

The AMSAT[®] Journal

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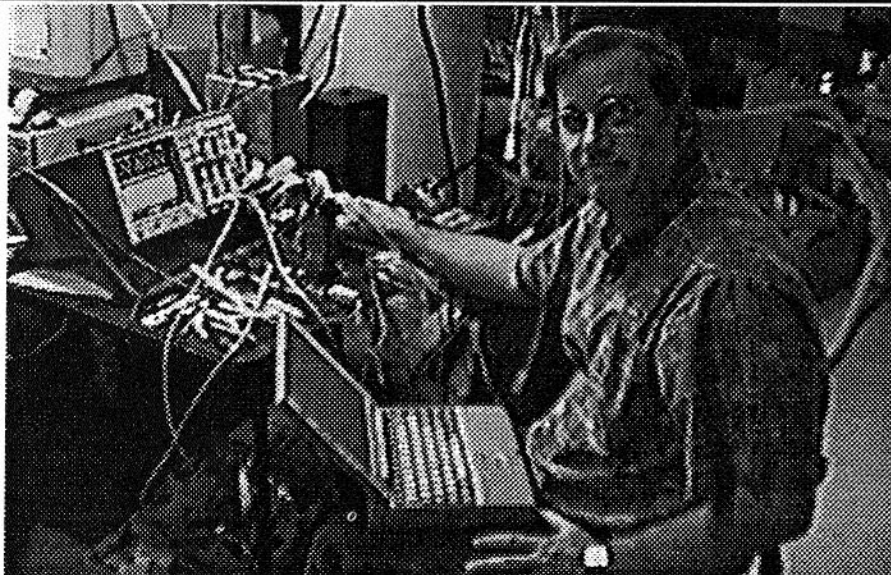
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Lyle Johnson, WA7GXD, in the basement of N3EUA's house, working to turn on the first RUDAK CPU board. The laptop computer contained a copy of all of the electronic design information for the board (schematics, circuit board art work, programmable logic designs, etc). When the RUDAK team gets together, one of the challenges is finding table space for all the laptops!

A Brief Update on Phase 3D RUDAK Progress

Bdale Garbee, N3EUA

n3eua@amsat.org

RUDAK is the digital communications processor slated to fly on AMSAT Phase 3D. It has architectural and software roots in the processors flown on AMSAT and SSTL microsats, but the design now includes modems based on DSP technology. RUDAK will provide digital capabilities to users of the Phase 3D satellite, and will also be the primary communications path for experimenters working on payloads such as GPS, SCOPE, and MONITOR to communicate with their experiments after launch.

The RUDAK project manager and lead hardware designer is Lyle Johnson, WA7GXD. Many others are contributing to the development and delivery of the system.

[continued on page 4]

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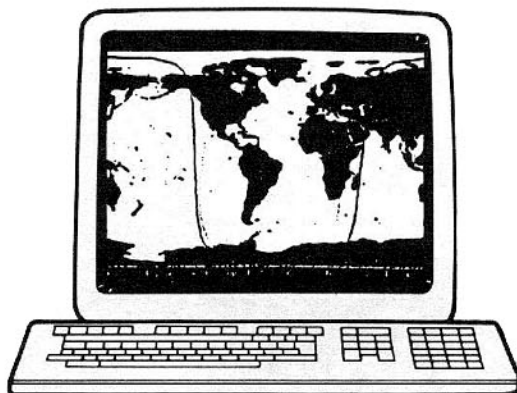
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AMSAT-NA can take your order for a Kansas City Tracker/Tuner or one of many Satellite Tracking software packages that support the KCT, such as Quiktrak, Graftrak, and WiSP for Windows. When you order thru them, they receive a Donation in your name towards the Phase 3D Project. Their telephone number is 301-589-6062.



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Journal*.

Where do we go from here? by Bill Tynan W3XO

In previous editorials, I have touched on what sort of project, if any, AMSAT should attempt following completion and launch of Phase 3D. This is not an easy decision. A reasonable approach might appear that we rest on our laurels for a few years and enjoy working Phase 3D (AO-?). Then, maybe, we might think about another project. This is roughly the approach AMSAT has pursued in the past. But what is the cost of following such a course? We have a lot invested in the Orlando facility both in terms of equipment, a satisfactory work environment and people. If we simply defer thinking about any new projects for a few years, it will be necessary to completely dismantle that facility and terminate the lease. It is clear that we will not be able to afford to keep the facility going with funds currently on hand. But, closing the facility would be unfortunate for a number of reasons. For one thing, it would not be cost effective. There would be costs associated with shutting down and storing all of the equipment. Then there would be additional costs associated with re-establishing a similar facility the next time we embark on a satellite project. Also, no matter what measures are put in place to prevent it, equipment deteriorates in storage, or is not there the next time it is needed. In addition, it might be hard to find a place as satisfactory as the current one has turned out to be, not to mention the difficulty of assembling a competent team to work on a new project.

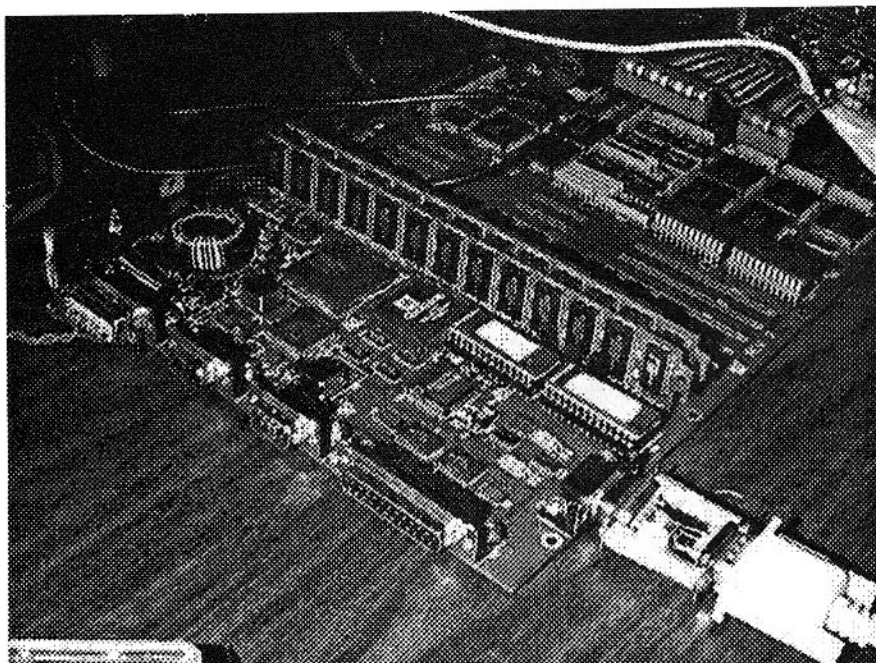
For all of these reasons, some of us feel that we should try find a way to keep the Orlando facility open, and as many of the current team occupied as possible. How can this be accomplished? One approach, which is being investigated, is to find some group which wants to build low-cost satellites, not necessarily amateur. If such a group can be found, and a suitable agreement concluded, we might be able to keep the facility, and its people occupied until we are ready to begin another amateur satellite project, perhaps in a few years.

Another approach might be to begin another amateur satellite project as soon as Phase 3D is launched. But, many question if the amateur community would be prepared to support another project, even approaching the magnitude of Phase 3D, so soon. Many have made significant financial contributions to Phase 3D and, understandably, would be loath to immediately again dig into their wallets to support another project. I happen to be of the view that they would not, but I could be wrong. Nevertheless, I am just as vehement that we should keep the Orlando facility going if at all possible; and intend to make every effort to try to find an appropriate way to do so. I feel strongly that this will give us a big head start when the time does come to mount another amateur satellite project.

I am aware that some feel that we should never attempt another project as extensive as Phase 3D. Citing some good reasons, they contend that we should attempt only relatively simple, small spacecraft of the Microsat class. They also argue that we cannot sustain any project which requires longer than about three years to complete. The assertion is also made that whatever project, or projects, which AMSAT does attempt will be decided on by those actually building the hardware, not necessarily by the wishes of the rank and file members. They contend that this is one of the prices for using volunteer labor. It is hard to argue with this logic. But, I believe that the amateur space community can find ways to sustain relatively large and complex projects, one of benefit to the most users. I submit that Phase 3D as well as Phase 3A (lost due to a launcher failure in 1980), Phase 3B (AO-10) and Phase 3C (AO-13) are demonstrations of my contention. I also have a strong conviction that AMSAT policy should follow the wishes of its members, as much as possible. I believe that the majority want a reliable, always available, real-time worldwide communications facility. I know this is not easy and may not even be possible, but I believe it should be our goal. I presented a possible outline for a type of spacecraft to accomplish this in the March/April 1997 journal.

As an AMSAT Board member, I would like to hear from you, the members, what your views are on these issues so important to the future of our organization. I am sure that the other Board members would like to hear from you as well. Also, as AMSAT members, I feel it important that you be informed as to the views various Board members, particularly those who are up for election this summer. (The Board members whose terms are expiring this year are: Dick Daniels W4PUJ, Junior deCastro PY2BJO, Bob Myers W1XT and the writer.) Shortly you should be receiving ballots listing the nominees for the next set of two year terms. One fast and convenient way to learn the opinions of those nominated is to send the candidates E-Mail messages and ask them. The AMSAT E-Mail system is there for you to use. Simply address the call@amsat.org to reach the various Board members and officers. For example, my E-Mail address is w3xo@amsat.org. I would like to hear from you and I will put my responses on the AMSAT Bulletin Board (amsat-bb), as well as directly answering the individual sending the message.

Only by the Board members knowing the views of the members and the members knowing how the various Board members stand on a variety of amateur satellite related issues, can AMSAT function as a democratically run organization, operated in accordance with the wishes of its members. To accomplish this, you must be informed and then you must exercise your views through your vote for the Board members of your choice. ■



The CPU B engineering unit used to drive modems for testing. The cabling connected on the left is power and IHU control, in the lower right is the ground support interface, and the ribbon cables in the rear attach to the modem board under test.

[RUDAK continued from page 1]

Hardware Design

Here is a quick summary of the Phase 3D RUDAK design.

There will be two independent processors, both NEC V53's. The V53 is similar to an Intel 8086, but with integrated I/O functions

and the ability to address 16 megabytes of memory. Each processor will have the full 16 megabytes of memory, typically used as 1 megabyte of program memory and 15 megabytes of solid-state disk. Each processor will also have 10 serial ports, and 16 DMA channels.

Each processor will have the following modem complement:

- Two 9600 baud hardware modems
- Four DSP modulators
- Four DSP demodulators

The two processors will also share a 153.6 kbit/sec hardware modem. Only the 9600 baud modems will be active initially, and after a reset. The 9600 baud modems are completely compatible with existing 9600 baud ground station modems.

Each processor will also connect to the two GPS receivers and the SCOPE camera, through serial ports, CAN bus, or both.

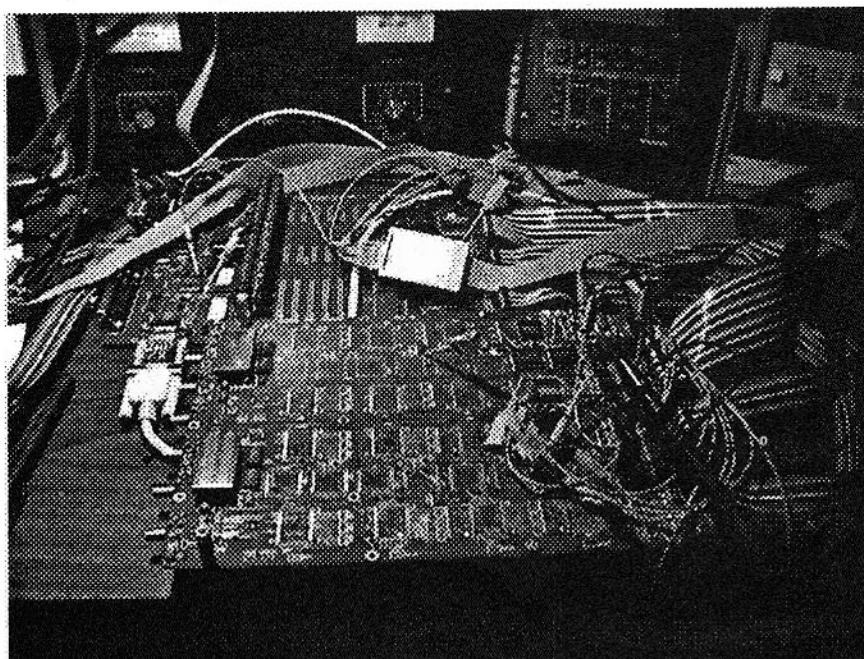
Each processor has a path to monitor the internal 400bps IHU telemetry stream.

Each processor connects via the CAN to other spacecraft packages, such as the charged particle and total dose detectors.

So, to answer the question, we'll have at least the current digital satellite standard of 9600 baud FM. We can have many other standards with the DSP modems, including the 1200 PSK standard; and as many esoteric standards as someone wants to write DSP code for.

Several modems can be running at the same time, appearing on the IF passband at different places. The link margins are such that we'll have to use most of the available digital downlink power to support a single 9600 baud downlink, such that the performance into a standard 9600 baud LEO ground station from apogee is the same for Phase 3D as it is for KO-23. We can appear on more than one downlink band at a time, however, and can simultaneously support other protocols that are more heavily coded and are at lower baud rates, or high speed downlinks to gateway ground stations with larger antennas.

Of particular interest is the fact that the NASA-standard rate-1/2 convolutional forward error correction code will optionally be available on the high-speed modem. This drops the data rate by 50 percent, to 76.8 kbits/sec, but provides enough *gain* from the FEC that it should be possible to receive this data downlink with a patch antenna on 70cm, modest receiver, and Pentium processor running the convolutional decoder. In other words, a really useful data downlink that will be receivable by almost anyone without needing to point antennas or own lots of esoteric hardware!



A shot of the RUDAK CPUB V53 processor board in the background and the DSP modem prototype board in the foreground. The large silver-colored blocks on the far left of the DSP board are AD9042 12-bit, 41 MHz A/D converters used in the front end of the IF receivers. The maze of logic analyzer clips to the right are sampling various timing signals during the debug of the V53 -

Physically, RUDAK is made up of four major circuit boards...two CPU boards, a hardware modem board, and a DSP modem board. The CPU boards are populated with a set of SIMM memory modules custom-made for this project, using very fast static RAM chips.

Status Report

At the time this is being written, in mid-May 1997, all of the pieces of RUDAK have been built and tested individually and in various combinations. If all goes according to plan, the full module will be integrated and tested, and the bootrom software completed. By the time you read this, we will hopefully have put the finishing touches on the module, and delivered it for integration with the rest of the spacecraft in Orlando.

Various members of the design team have taken photos at various points in the development of RUDAK. We are pleased to share a small selection of these with AMSAT Journal readers.

Summary

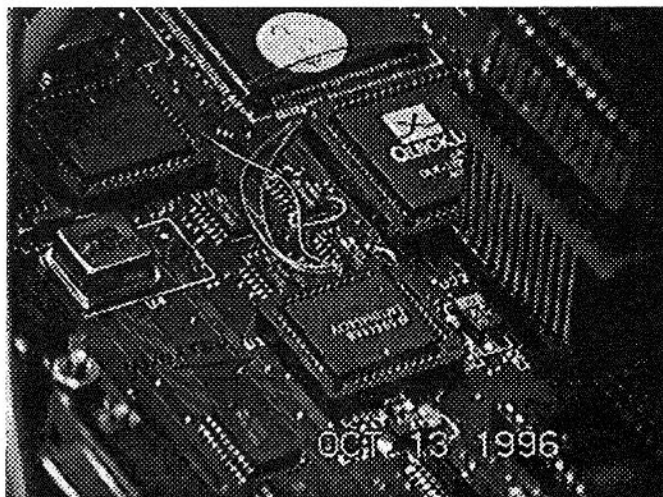
The Phase 3D RUDAK subsystem is the most sophisticated digital subsystem ever designed for an AMSAT satellite. It is intended to serve the needs of both average digital satellite users, and scientists whose experiments are flying on Phase 3D and for whom RUDAK provides the only facilities for communicating with their experiments. It is a pleasure to be able to report that the RUDAK hardware is nearing completion, and is about to undergo testing prior to integration.

This report is adapted from the RUDAK WWW page, accessible on the AMSAT WWW server at <http://www.amsat.org/amsat/sats/phase3d/rudak-u/>. Check there for updates on the project.

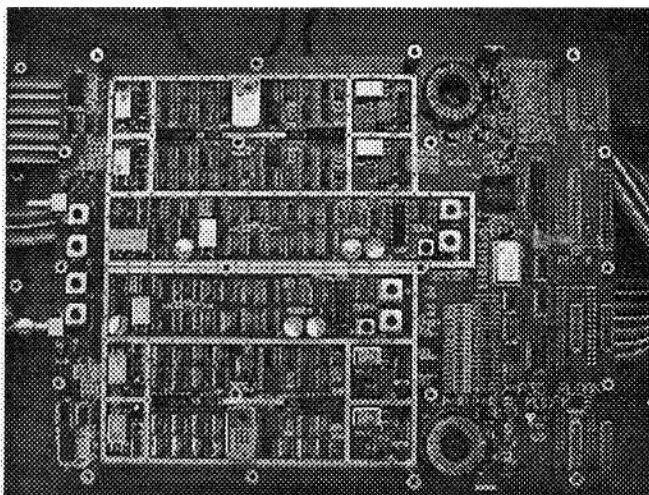
We have many more pictures available on the web than we can print in *The AMSAT Journal*! ■

Errata

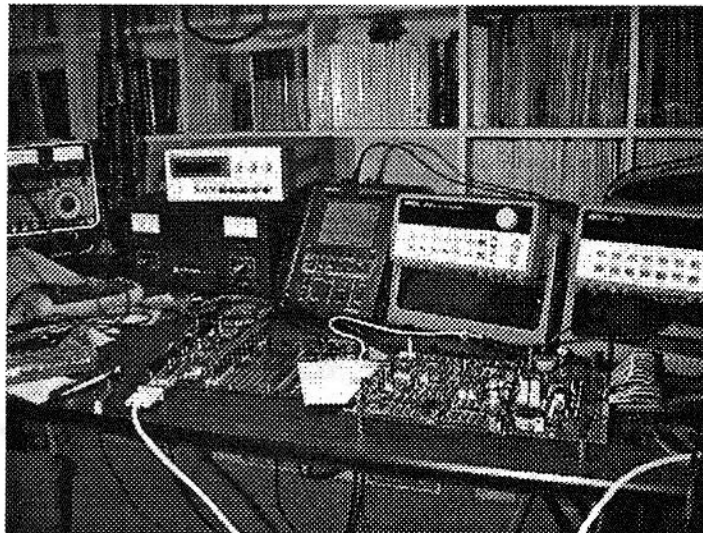
The day listed for holding the Houston Area AMSAT Net in the May/June 1997 issue (page 25) of *The AMSAT Journal* should be **Tuesday** instead of **Sunday**.



A closeup of one of the first V53 CPU boards turned on. To the right is one of the EPROM emulators sitting atop an adapter board that makes it look like the 2kx8 fused-link PROMs that we will fly on the satellite. In the rear is the CPU chip, the A/D converter is in the lower center of the shot, and some grass, or jumper wires, are visible in the middle of the board. Also of great significance in this shot is one of the two QuickLogic FPGA's that condense a large amount of logic into a small space. One is used for the EDAC control, and the other is used primarily for chip select logic for all of the I/O devices on the board.



This is the hardware modem PCB. It contains four 9K6 FSK modems, two 153K6 PSK modems, power supplies, and an analog acquisition subsystem for voltage, current, and temperature measurements. The large pair of shiny cases are TCXOs, which may allow us to make accurate Doppler measurements for orbit determination using the recovered bit stream of the high speed modem (rather than RF carrier).



This is a partial view of the lab at WA7GXD, showing some of the test gear being used to test and align the modems. Note that these modems operate at Phase 3D IF, not baseband.

An FO-20/FO-29/RS-10 Quad Antenna (Another Simple Antenna for the Apartment Dweller)

John A. Hackett, LA2QAA

The only problem with the previously described dual J-Pole for 2m/70cm is the characteristic break-in of the 3rd harmonic of 2-meters on 70cm (see the January/February issue of *The AMSAT Journal*). This can of course be eliminated with a well designed cavity filter. I am fortunate in having a commercial doubly tuned cavity filter which when tuned for 435 MHz ensures the third harmonic break in is not a problem.

However, realizing that most newcomers would not be able to obtain a commercial cavity filter and that the fair majority are not metal workers by trade, therefore probably couldn't make one....I decided to experiment a bit and see what could be done for those without access to a cavity filter.

The antenna I describe here was designed primarily as a simple transmit antenna for RS-10 in conjunction with an indoor 10m dipole hanging just below the

ceiling in my ground floor shack...I tried it as the transmit antenna on FO-20 using a 6 element 70cm beam on a microphone stand as the RX antenna....no preamp was used!....(Actually I tried the low noise 70cm preamp described in *The Satellite Experimenters Handbook* but found the signal to be more readable without the preamp.) Again for the newcomer, this has to do with signal to noise ratio...transistors make noise...at least BFR 901's do....an 0.5dB GaAsFET would probably make a difference but then again most newcomers won't have those either.

Anyway, on the morning of Shrove Tuesday, I heard and worked my friend Peter Pohlke, DG3GAQ on FO-20 using the quad and 6-element beam indoors. Since the beam is mounted on a microphone stand it is easy to turn using the so called *Armstrong* rotator. Again for the newcomer, remember that the more elements you have on a beam (ie: gain), the more precise your aiming needs to be. With a small 6-element Yagi for 70cm, the boom is only 90cm long. Of course you will have read about circular polarization but for now you will do just fine with the beam horizontally polarised. Regular readers of *Observations from Norway* will know I have circularly polarised beams and automatic tracking if need be. However, I find the fun went out of satellite operating with all the automation. Therefore the *back to the roots* approach. You can purchase a commercial 70cm mini-beam for less than the price of the materials to build (!) one so I won't describe that particular antenna, however, the quad can be made in two hours with scrap you can pick up anywhere.

FO-20's and FO-29's uplink are centered on 145.950 MHz and RS-10's on 145.880 MHz so I cut the quad for 145.900 MHz. The circumference is 210cm...it doesn't matter whether the four sides are exactly equal....as in a square....or slightly elongated in an oblong configuration...the preferred shape is of course a circular loop...giving most area but then the antenna if made with 3.5mm copper wire would not withstand the extreme weather conditions here on Frei Island next to the Norwegian Sea so I elected to use a square shape with

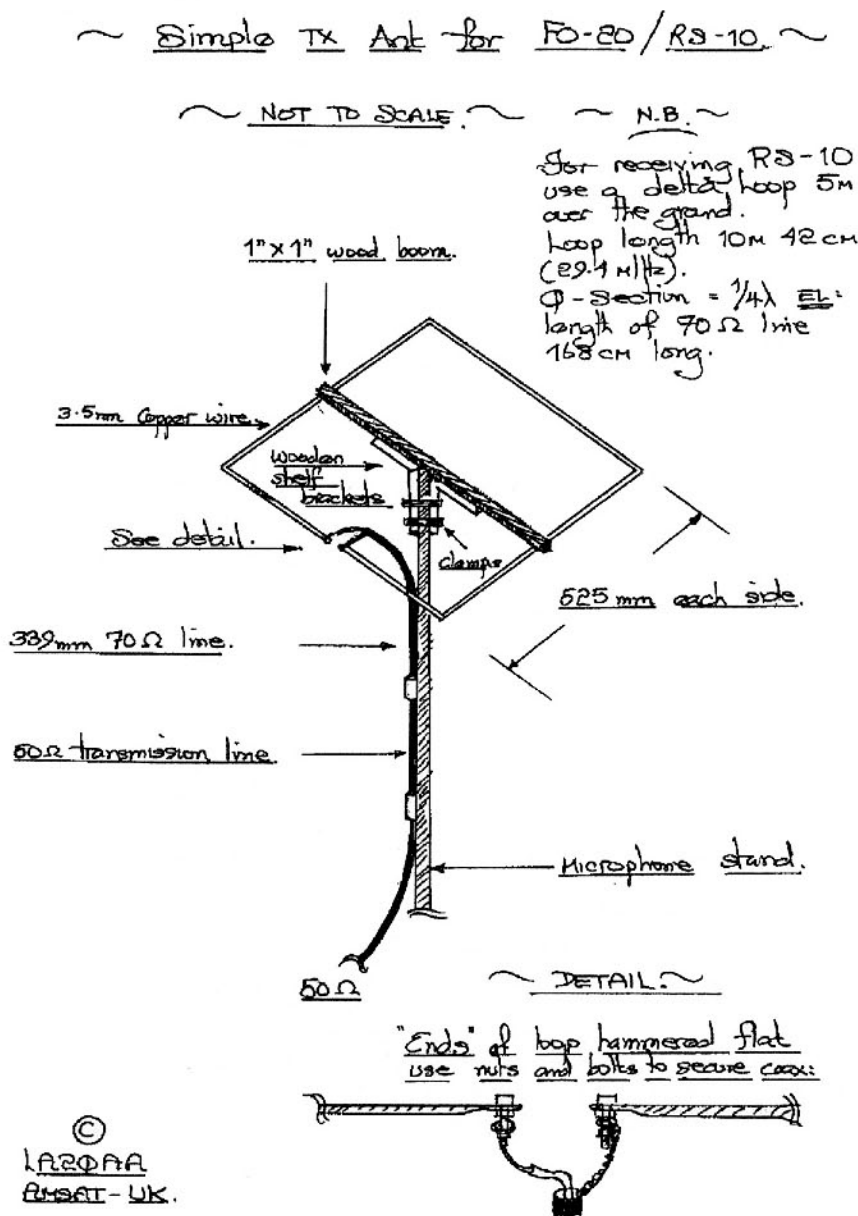


Figure 1. LA2QAA FO-20/FO-29/RS-10 quad antenna.

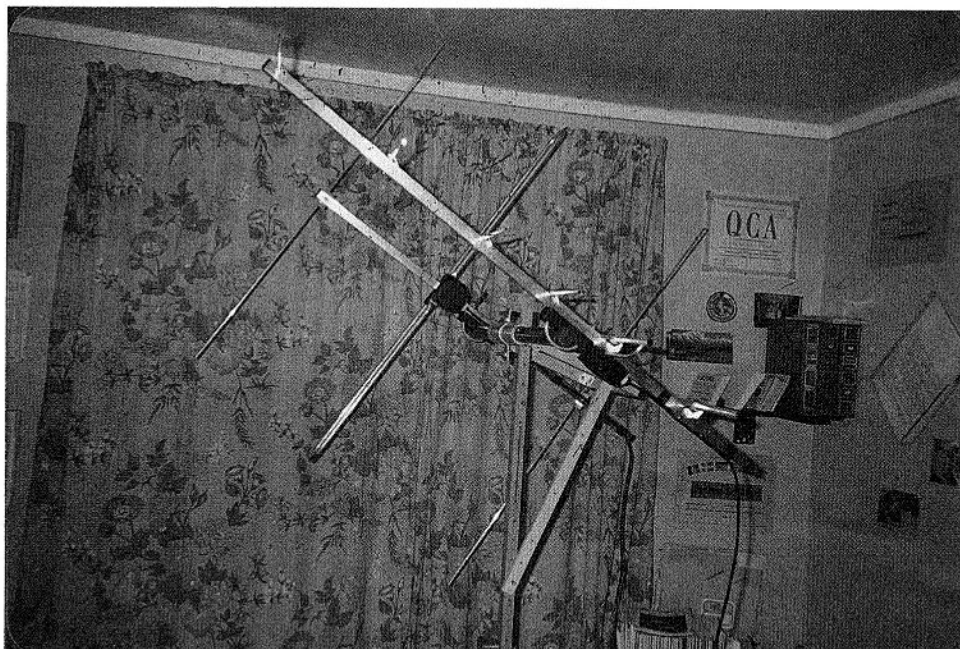
the radiating element as shown in the Figure 1. Two wooden shelf brackets are bolted to the end of a 1m length of broom handle...the broom handle is *laced* with a coating of black plastic electricians tape.....(As in the dual J-Pole...the tape *must* be black!...to keep the SWR down.....just joking folks!) It's to protect it from the weather because LA2QAA is too lazy (!) to coat it with varnish. A roll of tape is cheaper! and faster anyway. 3.5mm holes are bored in the ends of the brackets and the element wire is pushed through. Carefully measure and mark the element before bending so that there is 52.5cm on each side, making a total of 210cm for the quad loop. You can use a suitable connector for the feedline...I used an SO-239 because it was available but newcomers be aware that so called UHF connectors are definitely *not* recommended for frequencies in the UHF range. They are adequate at 2-meters but only just!...and they're not! weatherproof. Use N-Type connectors if you have them.

To match the nominal 100 ohm impedance of the loop to the standard 50 ohm impedance of the feedline you'll need a Q-matching section....this is simply an electrical quarter wavelength of 70 ohm line between the loops feedpoint and the main coax (see Figure 1). Actually at 2-meters, the impedance transformation is not that large...still, I recommend the use of the Q-match. The SWR with the Q-match is 1.2:1 at most....without it it's 1.6:1...usable...but for a couple of extra connectors and a bit of coax why not do the job properly....never mind the adage *it's near enough*, that's for the 20m brigade. At VHF and above one should make that little extra effort and aim for a (near) perfect match. Any EME'er will tell you 1.6:1 and 1DB of noise is far too much.

On the other hand we're not catering for the *expert*. He already knows! Therefore, a good compromise is the first goal.

A Postscript Observation's From Norway

Theory and practice...hrmm...I'm about to *rock the boat* again. Theory dictates that a vertical antenna is useless when a satellite is above about 50 degrees elevation...for instance, it's logical to assume the following....zero degrees to 45 degrees elevation, a J-Pole or other vertical outperforms a turnstile...above 45 degrees the turnstile is better....neither being as



A home-made indoor AO-27 antenna by LA2QAA. (See description of this antenna on page 7 of the May/June issue of *The AMSAT Journal*). (LA2QAA photo)

good as a beam of course but then again you have the *tracking* problem and anyway...lots of hams for various reasons don't have beams.

Of late I'd been getting bored with FO-20, known as SGS (still going strong), so I decided another challenge was needed....therefore microwaves were the next logical step. Due to the prevailing *financially embarrassed* situation I had to practice what I preached in a previous issue. Re: taking the Elmer idea one stage further and exchanging equipment *and* knowledge....the shortfall was the *beams n' rotators* found a new home and I was able to *reinvest*. To stay active locally on 70cm I found a collinear quite adequate. On the

morning of March 11, 1997, I suddenly felt *abstinence withdrawal symptoms* for FO-20 so decided to see if I could hear anything on the collinear....(NO PREAMP!). Imagine my surprise when FO-20 came over the *InstantTrack* horizon at zero degrees...(but well behind a very large mountain on the mainland)...perfect copy....well, it's to be expected really with a collinear vertical...is it not? My surprise turned to amazement! At the point of closest approach, FO-20 was at 355 degrees azimuth and 83 degrees elevation. Almost right over my head! And this was a vertical antenna *without* a preamp! Quite naturally I assumed this to be a fluke inasmuch as I was receiving some sort of reflection from the mountains on the mainland but I was so



The mobile AO-27 antenna showing the switching box. The upper box contains a GaAsFET preamp. Note the dish in the corner waiting for Phase 3D. (LA2QAA photo)

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2MCP14

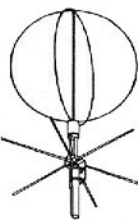
14 elements'
10' 6" boom

2MCP22

22 elements,
18' 6" boom

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surprised by the result that I decided to run a test later in the day when FO-20 would approach me from the southwest and go down to my northwest. Exactly the same result! I copied every single letter/code from the beacon from horizon to horizon....so what!...(one may well ask)...The point being as I have so often tried to bring home to the newcomer, you **don't** need to be a safecracker by profession to operate satellites. Of course the signals were not as strong as when I had my beams but the antenna I am talking about is just 1.5m in height, practically invisible to a *no antennas here* landlord and costs less than a pint of Norwegian beer! For these tests the antenna was at the sharp end of 15 meters of RG-214 coax mounted on a small home made stand....the tip was just 3m over the ground on the lawn!. My TX signal with 5 watts to a J-Pole....(see Jan/Feb issue)....was of course too weak for a good SSB QSO but perfectly! adequate for CW. Add a preamp to the collinear and *elevate* the TX power up to 10 watts and you'd no doubt have a good QRP SSB QSO on a pair of verticals!

As mentioned...I was *bored* with FO-20 and the beams and rotators. It had become *too easy* so what was needed was another challenge. Readers of *Observations from Norway* in the *OSCAR News* will have noticed the natural progression from a couple of years ago working RS-10 from an apartment in a city on indoor antennas...the move in QTH allowing outdoor antennas...the beams and rotators on AO-10 and AO-13... to the present day fully automated station on FO-29. I have of course learned a little along the way, but I find the the fully automated station doesn't tax my brain cell (only having the one!, I need to keep it active). So....what next? As previously mentioned, I had unexpected success with a 5/8 wave vertical, this is totally illogical because a 5/8 wave vertical (theoretically) has a very low vertical radiation angle and should be quite useless! over 30 degrees elevation. Still....if it works on receive!.....I constructed a 2-meter version to see if I could communicate with low power and a pair of verticals. The result? Very disappointing (why was I not surprised!).....I could hear myself (because I knew I was there) but the other stations could not hear me. After adding a 70cm preamp I could hear myself reasonably well but still nobody else realised I was calling them. (Have we all become too used to signals 6dB louder than the beacon?).

Despite the weak signal on FO-20 I decided to test out a theory. I constructed a 15m sloping V-beam (to transmit on RS-12's mode K and receive RS-10's mode A) tuned the TS-520 to 29.370 MHz and put out a call on the old TR-700G with just 10w to the J-Pole. I hadn't completed the call before *me' old mate* John Bolton, G3FBN came back with...*long time no see*...(great to hook up again John!)....Now there seems to be a lesson here....can it be?....the more technically advanced the station becomes the less that station relies on one of *the* most important receiving aids...namely, *a pair of ears*! It is a fact (!) that nobody could or would hear me on FO-20...but on RS-10 the replies were always immediate...using the same transmitting equipment. Was this sheer coincidence? I don't think so. Perhaps we should all make an effort to stress the importance of a *good* receiving station to the potential newcomer.

I have previously mentioned the helpfulness of our colleagues *across the pond* namely Bill Hook, W3QBC office volunteer (which means he works on *your* behalf too!) at the AMSAT-NA offices at Sligo Avenue. Needless to say, without remuneration other than knowing he's contributing something to our organisation. Once again Bill came to my aid in obtaining a hard to get hold of item! Thank you Bill! If everyone was as helpful as you have been it would be a lot easier for the newcomer. Having said that, I must also mention whenever I have telephoned AMSAT-UK *higher echelons* (Ron Broadbent, G3AAJ or Fred Southwell, G6ZRU) from Norway, they have been *most* helpful and encouraging. So to any potential newcomer I can say do **not** feel inferior because you haven't got the experience. You need only ask in a sensible, polite way. *Only time-wasters get a flea in their ear*. For our overseas potential newcomers may I respectfully suggest that one is coherent on the telephone...i.e. don't panic!...write what you need to ask on a piece of paper and speak slowly and clearly. People *will* realise you are communicating in something other than your mother tongue....unless of course you're American!, in which case please speak German so we can understand you....(just kidding!, guys). The point is **do not** assume the party concerned will make fun of your command of the language. I assure you they will respect you for it.

Most people over the age of 105 remember the Pye Westminster Taxi radio.

For years I have used the changeover relays on 2-meters. (The old Pye's operated between 130 and 170 MHz.) As a *test* I tried one on 70cm and it worked every bit as good as a 50 pound-plus coaxial relay and didn't cost a penny!

Pleasantly surprised to receive a QSL card from JARL depicting 8J1JCS on it's test bench....(one may recall I mentioned my somewhat *premature* QSO with Mike Seguin, N1JEZ immediately after launch. Apparently the boys at JARL were monitoring those of us who were a bit too fast on the trigger.) At least we didn't do any permanent damage. I shall endeavour to *control myself* when Phase 3D lifts off.

One may also recall my futile attempts to persuade LA5QIA to join AMSAT-UK and the fact that I mentioned he joined AMSAT-SM no doubt to spite me. I hereby grovel! He is now a member of both! AMSAT-SM and AMSAT-UK...thereby *doing his bit*. Good on ya' Paul. Try to encourage a few more!

More theory and practice. The two usually being incompatible! I've been *messing* about with antennas again and have

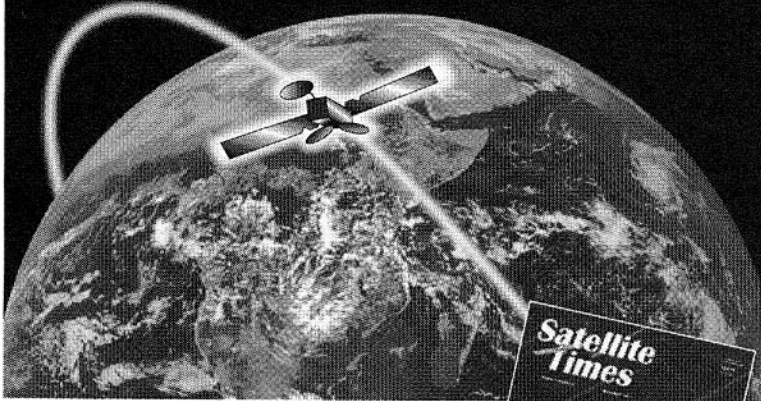
noted a few interesting *quirks*. It's a fact that if the phasing lines of a two (or more) antenna array for circular polarization are not perfectly symmetrical...the main lobe will be offset from the direction in which the array is pointing. Just recently I had the opportunity to try a pair of commercial 5 element 2m Yagi which I placed on the crossboom at 45 degrees or 90 degrees in relation to each other. I made sure the feeds were exactly as shown in the old *Satellite Experimenters Handbook*...carefully measured the phasing lines....I had one and a quarter wavelength (electrical) of 70 ohm coax on one side....(remember a halfwave of line repeats the input impedance no matter what the velocity of the line). On the other side I had one and a quarter wavelength of 50 ohm line *plus* a quarter wavelength of 75 ohm line for the delay...(with the *horizontal* one lagging the *vertical*)....the lines were *dipped* as opposed to cutting to a *formula*. Now, theoretically, this should give circular polarization. I used FO-20's beacon as my reference and the rotator as a guide. What actually happened was the main lobe was skewed 30 degrees! from the axis of the array.

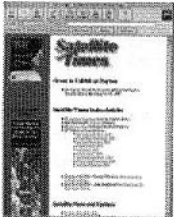
I tried the experiment on consecutive days so am pretty sure it wasn't an idiosyncrasy of propagation. My signal was not enough to *melt* FO-20's front end transistor so I decided to play around a bit. The configuration giving the best *real time/real life* results was a single *vertical* 2m five element for the uplink and a six element 70cm *horizontal* for the downlink. I had a very respectable signal on all FO-20 passes (with QSO's to prove it) and a *ginormous* (gigantic + enormous) signal on RS-10. In fact I couldn't *hear* any difference compared to my two by 11 element crossed Yagi (you would need a very sensitive meter to *see* the difference). The point being, the simple array of just two antennas was just as functional as the *big* array on actual QSO's. Potential newcomers take note! And remember you won't need 18-stacked Yagi's for Phase 3D!

I had a terrible time trying to get G4*** to understand why my signal was weak when according to his *InstantTrack* program the satellite was 30 degrees over his horizon and at least 20 degrees over mine. What *InstantTrack* **does not** show are the whopping great big mountains on the

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mainland to my northeast. A 2m/70cm array just does not work on the long path principle and unfortunately these mountains *refuse* to move no matter how much I swear at them. So for the benefit of G4*** that is my *excuse* for the drop in signal strength. However, they're quite good reflectors at 2.4GHz!

Regulars readers of *Observation's from Norway* will recall that it wasn't too long ago since the PC *threw in the towel* halfway through an attempt to write another *Observations*. The monitor also decided it had *had enough of this* too. The first reaction was of course panic! But after a quick think, I decided to remove the screencard from the present PC and change it for the one in the junkbox. The idea was to use the old EGA monitor which has been relegated to the loft (just in case). Anyway, the system works...not well but it works. Not bad for a grade one computer illiterate.

I forewarned the *paying public* a report would follow re: my attempt at the G0MRF 2.4GHz RX converter. Be warned! Sneeze and that's the end of it! On opening the package to check the components I noticed that David had included a speck of dust! I wondered why....on closer inspection the speck turned out to be an IC amplifier! There were even 6 little legs on it! Enough to make any termite send out a mating call. These things are not designed for the constructor who is faint hearted and blind in all three eyes. However, with the use of two toothpicks and a rubber band...non-conductive tweezers! to the uninitiated....and a 100:1 magnifying glass the kit finally came together. Ah yes, but would it work? I didn't hold out too much hope. This was entirely due to my inexperience with microwave construction, certainly *not* to the quality of the kit which is excellent! On connecting the signal source and following the instructions...for once in my life...the kit worked perfectly! In three words, *I am amazed!*

The description of the FO-20/FO-29/RS10 antenna earlier in this article is designed primarily for the newcomer and/or the operator who for one reason or another is unable to install automated antenna systems. However, you won't need sophisticated aerial systems for Phase 3D. I am at present in the process of building G0MRF's 2.4 GHz receive converter for Mode-S. Antennas for this band won't need to be very large at all The

OSCAR 13 Mode-S operators will no doubt use their dishes but anyone building the G0MRF converter will find a 16-turn helix quite adequate due to the high gain in the converter. A 16-turn helix is only 47cm long and 4.5cm in diameter. Even the most severe landlord would find it hard to call such an antenna an eyesore! G4IHJ stated (correctly) there may be a problem with 2.4 GHz receive converters that have an IF of 435 MHz. You need the 70cm rig to transmit. One solution would be to make up (or purchase) a 70cm to 2m converter and use the 2m rig to receive while transmitting on the 70cm rig. The harmonic problem?...filters!. A well known firm in Broxbourne manufactures a simple 70cm/2m converter kit. It is inexpensive and it works too! (Circuit Distribution, LTD., Park Lane, Broxbourne, Herts. EN 10 7NQ, England) I know because I've built one. I didn't have to purchase another one though. I just blew the dust off my old Microwave Modules 70cm/10m transverter. My TS-520 tunes from 29.1 to 29.7 MHz at the higher end of 10m but by changing the original MM crystal from 101.5 to 101.750 I can receive from 435 to 436.7 MHz which will cover all Phase 3D's frequencies on 70cm as well as FO-20/29. At the same time, on the low range of the MM transverter the original 101 MHz crystal covers 432 to 434 MHz. G0MRF's S-band RX converter translates 2400 MHz to 432, 2401 to 433, 2402 to 434 etc. so it seems feasible that I can use the MM transverter as a second IF so that DOVE's 2401.220 MHz beacon would be received via the G0MRF converter at 433.220 as the first IF then using the MM transverter on its low range for the second IF the signal would be received on the TS-520 at 29.220 MHz (theoretically!). I haven't tried it yet because the TS-520 doesn't have FM however I can test the theory by using the 2.4 GHz signal source. Watch this *space*! Once again the object of the article is to try to bring home to the newcomer that it is *not* necessary with a large bank account, a lot of *space*, etc. to enjoy operating on satellites. (You must be interested or you wouldn't be reading this, would you!)

I can assure you I get tremendous pleasure out of experimenting with satellite operating...with very! limited means....if you haven't got exactly what you need for a certain project, *improvise*! If you don't try, you won't learn. Most of what the experts say is perfectly true but usually they're talking about optimum station

setups. Doing the same thing for less is both rewarding and fun! And after all isn't that the name of the game?

Paradise Island, Norway? It's the 4th of April as I type this...there's half a meter of snow on the ground and the wind is *ripping* through the old farmhouse. Outside it's bitterly cold. So what possesses one to emulate a penguin? Family commitments, money (read: "lack of") the reasons are many but had I a choice I would rather be in Bermuda or back on Gibraltar or even Crewe at this time of year is more hospitable, weather wise.

Very strong downlink signals from RS-16 using the Microwave Modules transverter and the TS-520. Also interesting is the fact that I compared the signal with that received using the modern TR-851E direct. The antenna used was a six element mini beam indoors! The old transverter/TS-520 combination was *better* than the modern TR-851E (newcomers take note!). Modern synthesisers are OK as a *compromise* but they're noisy! (Of course, with RS-16, no preamp is needed... unless you're five shades of deaf!) You should be able to receive RS-16 with a matchstick covered with silver paper stuck in the antenna connector.

As always....criticisms to the editor, praise and other goodies to me!

73, John.

PS...Anybody got an explanation why there is so little CW on FO-20? ■

Virginia Air & Space Center Special Event Station Operations

The Virginia Air & Space Center (VASC) Amateur Radio Group, Inc. will operate KE4ZXW Special Event Station at the VASC, Hampton, VA on Saturday and Sunday, September 27-28, 1997. The VASC Amateur Radio Group, an ARRL affiliated club, is celebrating two-years of uninterrupted 9600 baud automatic satellite operation at the VASC Amateur Radio exhibit. The Special Event Station will operate via KO-23 or KO-25 on both days from 0000 to 2400 UTC. They will also operate HF from 1500 to 2200 UTC on 7.625 MHz at the top of the hour, and 14.265 MHz at thirty minutes past each hour. An anniversary QSL card will be issued to those sending QSL and a SASE to Ed Brummer, W4RTZ, 108 Oyster Cove Road, Yorktown, VA 23692. ■

Real Gain of the Phase 3D On-Board L-Band Antenna

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This article provides an analysis of the carrier to noise ratio (C/N) for different antenna gain and receiver noise figures for the Phase 3D satellite. The noise level is given by a sum of the antenna and receiver noise temperatures. The antenna noise temperature depends on the beamwidth and so on the gain. Because in the center of the antenna pattern there is warm Earth surrounded by cold space, the antenna noise temperature is lower if the antenna gain is lower too. Any contribution of the receiver noise temperature is then more significant.

The Phase 3D satellite will carry linear transponders besides other equipment. The uplinks are in V, U, L, S, and C bands and the downlinks in V, U, S, X, and Ka bands. The transponder receiver and transmitter will be switched by means of the IF matrix for the selected crossband operational mode.

Phase 3D will be placed in a high elliptical orbit with an apogee height of about 47,000 km. The on-board antennas are Short-Back-Fire (SBF) for the L-band and a small dish antenna for the S and C-bands. The proposed antenna gains for all three bands were 20 dBi [1]. Because of dimensional limitations, the experimental investigations have shown that the achievable gain of SBF for the L-band is between 15 - 17 dBi. On the other hand, a higher isolation between antennas has been achieved than had been envisioned. For this reason, it is possible to simplify the filters at the receiver input and to improve the noise figure of the receiver itself. There is a question on how much it is possible to compensate the loss of the antenna gain in this way?

Antenna Noise Temperature Calculation

Let $T_b(\vartheta, \varphi)$ be the brightness temperature of a radiating body located in a direction (ϑ, φ) where the gain of the antenna has a value $G(\vartheta, \varphi)$. Ω is the solid angle. The antenna noise temperature T_A is thus [2]:

$$T_A = \frac{1}{4\pi} \iint T_b(\vartheta, \varphi) G(\vartheta, \varphi) d\Omega \quad [1]$$

Provided the antenna gain is equal to the value G in the whole circle area A and the zero outside this area, shown in Figure 1a, for T_A it can be written, according to Figure 1b:

$$T_A \approx \left(\frac{GW}{BW} \right)^2 (T_e - T_s) + T_s \quad [2]$$

where T_e and T_s are the brightness temperature of Earth (290K) and of space (30K), respectively, GW is the angle width of the globe (Earth) from the point at apogee (for $ha = 47000$ km, the $GW = 13.6$ degrees).

The beamwidth BW is calculated by using the cosine theorem (Figure 1a):

$$BW = 4 \arcsin \frac{1}{\sqrt{G}}, \text{ where } G = 10^{\frac{G[dBi]}{10}} \quad [3]$$

Real Gain

For the purpose of this analysis, the real gain (RG) is defined by antenna gain

($G[dBi]$) decreased by the relative system noise temperature expressed in dB:

$$RG = G[dBi] - 10 \log \frac{T_A + T_r}{290} \quad [dB] \quad [4]$$

where T_r is the noise temperature of the on-board receiver and 290K is the reference temperature.

For T_r and noise figure F it holds:

$$T_r = 290 (F - 1), \text{ where } F = 10^{\frac{F[dB]}{10}} \quad [5]$$

The RG then represents a difference C/N for a different antenna gain and receiver noise figure.

Discussion

The analysis is only an approximation to the real situation. Away from apogee, the globe width is relatively wider but because the satellite distance is lower, the link calculation is no more critical. The calculated data are presented as Table 1 and

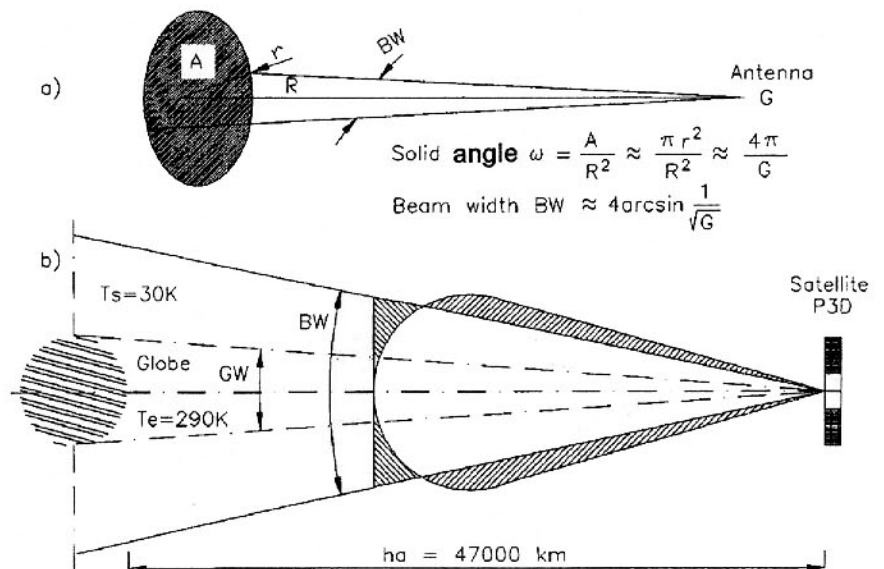


Figure 1. a) Antenna beamwidth BW calculation from the solid angle as a function of the antenna gain G. b) Schematic drawing demonstrates the ratio between warm and cold space for Phase 3D antenna at apogee.

in graphical form in Figures 2 and 3. As expected, the influence of the receiver noise temperature is greater for lower antenna gain. For an antenna gain 20 dBi and noise figure of the receiver 3.5 dB, the real gain (RG) is 17.7 dB. The same real gain can be achieved by the antenna gain 17 dB and noise figure 2 dB. As mentioned above, the higher isolation between antennas allows us to simplify the filters at the LNA input and thus to improve the receiver noise figure. With the redesigned LNA (with noise figure 1.2 dB), an effective receiver total noise figure of about 1.9 dB has been achieved. The majority of the C/N loss has therefore been compensated.

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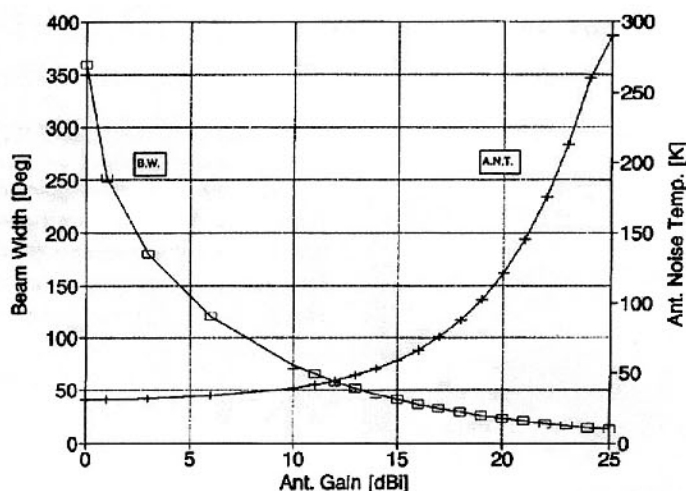


Figure 2. Dependence of the antenna beamwidth and antenna noise temperature on the antenna gain.

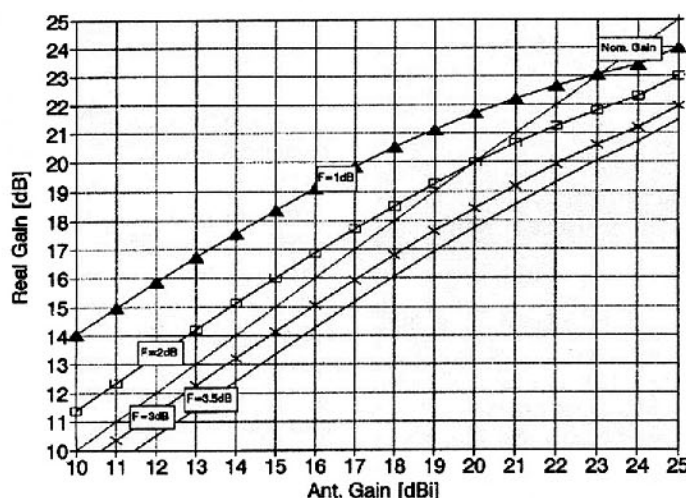


Figure 3. Real gain for different receiver noise figures versus antenna gain.

TAB.I. P3D RECEIVING SYSTEM ANALYSIS

Ant. Gain [dBi]	Ant. Gain	Beam Width [deg]	Ant. Noise Temp. [K]	Real Gain F=1dB [K]	Real Gain F=2dB [dB]	Real Gain F=3dB [dB]	Real Gain F=3.5dB [dB]
10.00	10.00	73.74	38.84	14.06	11.41	9.39	8.56
11.00	12.59	65.48	41.22	14.97	12.36	10.36	9.54
12.00	15.85	58.19	44.20	15.86	13.30	11.32	10.50
13.00	19.95	51.75	47.96	16.73	14.22	12.27	11.46
14.00	25.12	46.04	52.69	17.56	15.13	13.21	12.42
15.00	31.62	40.97	58.65	18.36	16.01	14.14	13.35
16.00	39.81	36.48	66.14	19.13	16.87	15.05	14.28
17.00	50.12	32.48	75.58	19.85	17.70	15.94	15.18
18.00	63.10	28.93	87.46	20.52	18.50	16.80	16.07
19.00	79.43	25.77	102.42	21.13	19.26	17.63	16.93
20.00	100.00	22.96	121.25	21.70	19.97	18.43	17.76
21.00	125.89	20.45	144.96	22.20	20.63	19.19	18.55
22.00	158.49	18.22	174.80	22.65	21.24	19.90	19.30
23.00	199.53	16.24	212.37	23.04	21.79	20.57	20.01
24.00	251.19	14.47	259.67	23.38	22.28	21.18	20.67
25.00	316.23	12.89	290.00	24.00	22.99	21.95	21.46
Equal	(3)	(3)	(2)	(4)	(4)	(4)	(4)

Table 1. Phase 3D Receiving System Analysis.

Higher Speeds with the G3RUH 9600 baud Packet Radio Modem

James Miller G3RUH

g3ruh@amsat.org

The modem is capable of speeds up to 64000 baud. This limit is set by the maximum rate that the DAC chips can operate. This note describes how to achieve rates from 4800 to 64000 baud. The slowest speed is suitable for 12.5 kHz channelised radios. The highest speed suits radios that have broadcast FM bandwidth filters.

To implement a higher speed you need to:

- Increase your TXData rate (!)
- Increase the associated TXClock
- Change some analogue filter components proportional to the speed increase.

It is not necessary to change either of the eeproms. If you are going for a higher speed, it is likely that the radios involved are *specials* and you will already have wide bandwidth and flattish group delay, so the loopback selection 0 from the standard ROM will be OK.

Table 1 suggests the best conditions for different speeds. Component references are for my own PCB card. Clones are different.

These modifications have been tested in both amateur and commercial service. All comments gratefully received, and added to the database. ■

Data Rate - Baud

Comp	4800	9600	19200	38400	64000
R6	220k	100k	47k	22k	15k
R16	100k	100k	100k	47k	15k
R17	82k	82k	82k	39k	12k
R18	39k	39k	39k	18k	5k6
R19	27k	27k	27k	15k	3k9
R21	100k	100k	100k	47k	15k
R22	56k	56k	56k	27k	8k2
C18	4n7	4n7	4n7	1n	680p
C20	220p	100p	47p	22p	12p
C26	(470p	220p	100p	100p	220p)
C27	(2n2	1n	470p	470p	1n)
C28	(2n2	1n	470p	470p	1n)
C29	(6n8	3n3	1n5	470p	470p) 2% or
C30	(220p	100p	47p	47p	100p) better
C31	(1n	470p	220p	220p	470p)
C32	(2n2	1n	470p	220p	150p)
Deviation +/-	1.5	3	6	12	20 kHz) In FM
IF Bandwidth	8	15	30	60	100 kHz) Service

Table 1. Best components for different modem speeds.

IPS - High Level Programming of Small Systems

by Karl Meinzer DJ4ZC

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*Net proceeds from the sale of this book will be donated to the
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How Much of a Transceiver's Power Output Arrives at the Antenna?

Franz J. Bellen, DJ1YQ

Translated by John Bubbers, W1GYD

This article (*Editor's note: Originally appearing in the AMSAT-DL Journal.*) is intended to encourage a close examination of the station's transmission facilities. A method is proposed by which the power at the antenna can be determined from the shack. This method can also be used to enhance the station's facility for the new Phase 3-D satellite.

Only a fraction of the transceiver's power ever reaches the transmitting antenna. The amount of power received by the antenna depends on the VSWR and on the total losses in the feed system.

The forward power, P.Forw, and the reflected power, P.Rev, can be read directly at the antenna with the aid of a directional power meter connected between the coaxial feed line and the antenna. The difference between P.Forw and P.Rev is the power fed to the antenna.

From the P.Forw and P.Rev the standing wave ratio, VSWR, can be calculated as follows:

$$VSWR = (1 + \sqrt{P.Rev/P.Forw}) / (1 - \sqrt{P.Rev/P.Forw}) [1]$$

where:

VSWR = Voltage Standing Wave Ratio

SQRT = Square Root

P.Rev = Reflected Power

P.Forw = Forward Power

While this method is correct it is very inconvenient. Who would want to stand on a ladder at dizzying heights to read a meter. Besides, this method is time consuming if the VSWR is to be measured over the entire band, since the operator has to run back and forth between his shack and the ladder. It is assumed that these are *good weather measurements*.

Analytical Determination of the Power

The measurements can be made more comfortably from the shack. The meter is connected between the transceiver and the antenna feed point where the forward and reflected powers are measured. However, both of these measured values ignore the losses in the coaxial cable, the antenna pre-amp, possible switches, etc. and must be

corrected for these losses. The VSWR can be calculated using the formula introduced above, using the newly calculated power data for the power received at the antenna.

Examples for 2 meter and 70 cm Bands

These measurements were made at the author's antenna installation.

Losses between Transceiver and Antenna

The power losses in the feed line must be made separately for each band.

The following coaxial cable types were used:

- RG213U: Losses per 100 meters at 145 MHz: 8.5 dB, at 435 MHz: 15.8 dB
- AIRCOM: Losses per 100 meters at 145 MHz: 4.5 dB, at 435 MHz: 7.5 dB

2 Meter Losses

8 meters RG213U.....0.68 dB
Preamplifier.....0.20 dB
15 meters AIRCOM.....0.68 dB
Total Loss at 2 meters.....1.56 dB

The power loss ratio can then be calculated as follows: $P1/P2 = 10^{1.56/10} = 1.43$

70 Centimeter Losses

8 meters RG213U.....1.26 dB
Mode J Filter.....0.20 dB
Pre-amp.....0.40 dB
14.5 meters AIRCOM.....1.09 dB
Ant.-match.....0.01 dB
Total Loss at 70 cm.....2.96 dB

The power loss ratio can then be calculated as follows: $P1/P2 = 10^{2.96/10} = 1.98$

Results for the 2 meter Band

The measured 2 meter values at the transceiver are shown in Fig. 1. In order to determine the forward and reflected power at the antenna terminals, the following correction factors must be considered:

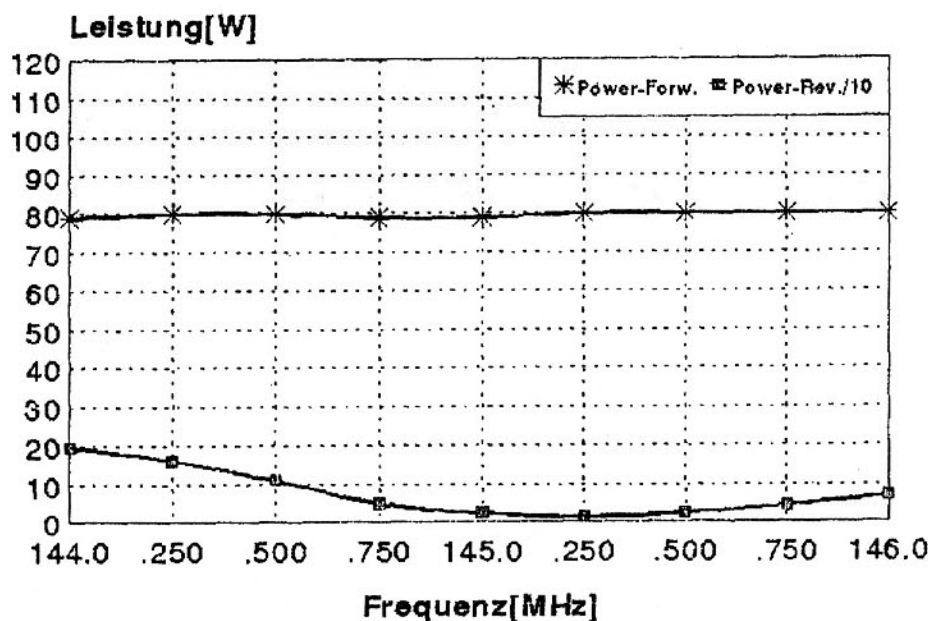


Figure 1: Power Measurements at the Transceiver (2 meter Band) Leistung[W] = Power[Watts]
Frequenz[MHz] = Frequency[MHz]

- The forward power measured at the transceiver output has to be reduced by a factor 1.43 (refer to 2 meter losses).
- The reflected power measured at the transceiver output has to be increased by a factor of 1.45 (refer to 2 meter losses).

The differences of the new numerical values result in the antenna input power, thus consideration of the formula for the standing wave ratio (refer to [1]) also gives the VSWR at the antenna. Figure 2 is a graphic presentation of these results.

From Figure 2 it can be concluded that only approximately 65 to 70 percent of the transceiver's output power is available to the antenna, and that the calculated VSWR closely agrees with the Maspro Company's VSWR claim.

70 cm Band Results

The measurements and calculations for the 70 cm band were performed similar to those for the 2 meter band. The results appear in Figures 3 and 4.

The antenna's input power is only 45 to 50 percent of the transceiver's output power according to these graphs. The VSWR is noticeably worse than that shown in Maspro's data sheets. The reason is the Mode-J-Filter, which is absolutely necessary for this activity. In Figure 5 the effect of the filter is clearly shown.

Measurements of this type (Figure 5) can also be used to check the long term performance of an antenna's efficiency. The long term repeatability should be similar to this figure. The smallest changes in the antenna, for example input impedance, moisture in the feed lines, etc., are noticeable in the VSWR.

Summary

This presentation should be an inspiration to check the transmitting setup,

- for the enhancement of the station's ability to work future Phase 3D satellites,
- for a long term performance check of the antenna system,
- for the many reasons to install an in-line power monitor (long term

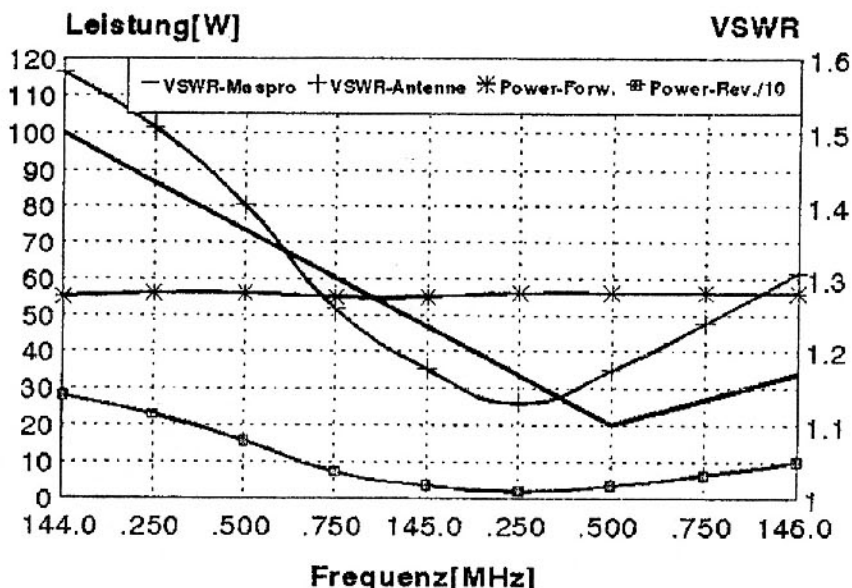


Figure 2: Calculated Values at the Antenna (2 meter Band) Leistung[W] = Power[Watts]. Frequenz[MHz] = Frequency[MHz]

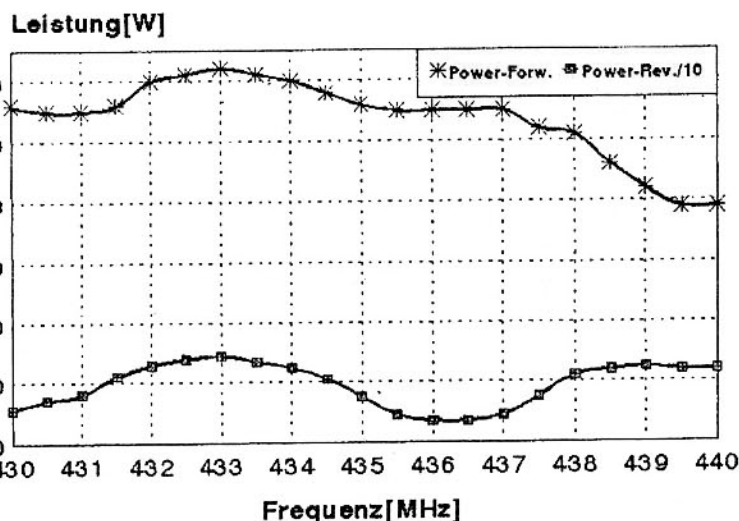


Figure 3: Power Measurements at the Transceiver (70 cm).

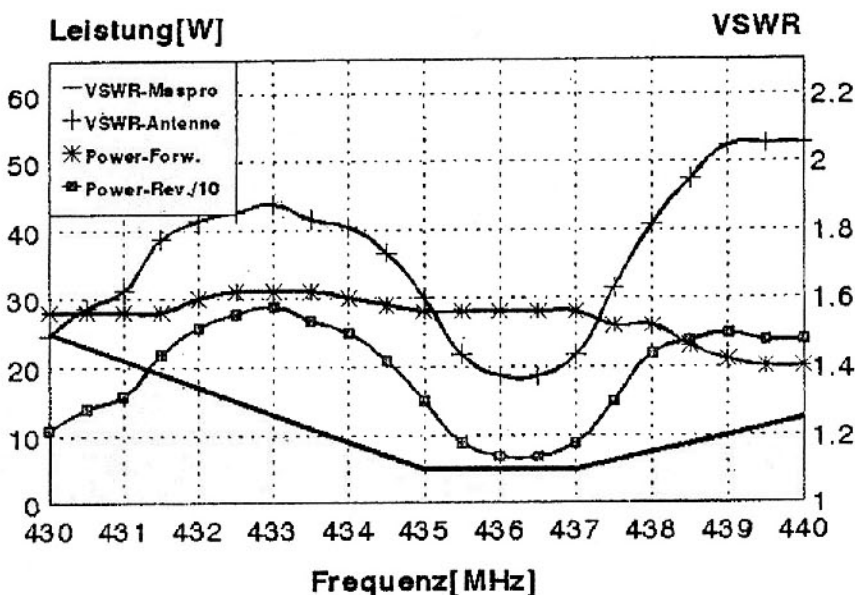


Figure 4: Calculated Values at the Antenna (70 cm)

monitoring of the transceiver and power amplifier).

Translator's Note on Figure 5: The phrase *at various dates indicated* added for clarity. The two formulas for the Power loss ratios would more likely be expressed differently in the US. For example, the formulas in the German text are currently expressed as:

$$P1/P2 = 10 E 1.56/10 = 1.43$$

$$\text{and } P1/P2 = 10 E 2.96/10 = 1.98$$

In the USA these terms would more probably be expressed as follows:

$$P1/P2 = \text{antilog}(1.56/10) = 1.43$$

$$P1/P2 = \text{antilog}(2.96/10) = 1.98 \blacksquare$$

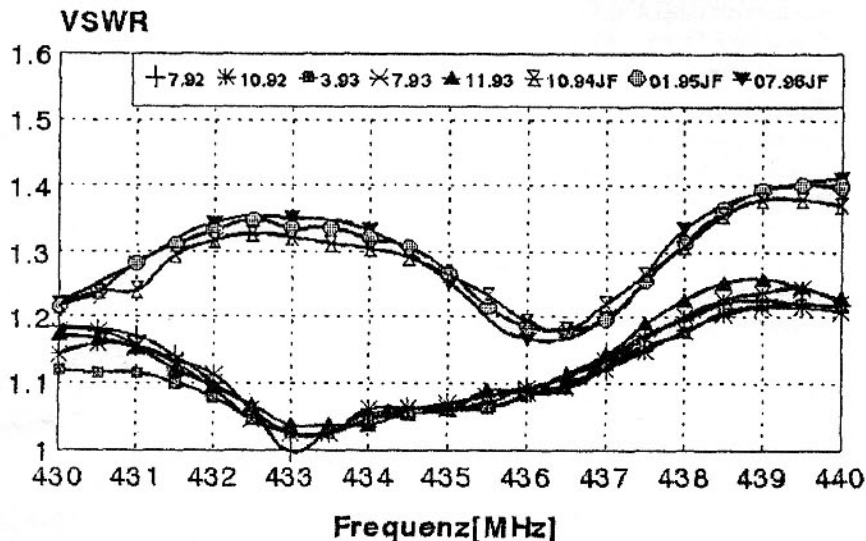


Figure 5: VSWR Measurements at the Transceiver (70 cm), Influence of the Mode-J-Filter at Various Dates Indicated.

Satellite Orbital Elements

Ray Hoad, WA5QGD

Satellite	AO-10	AO-27	FO-28	FO-29	RS-10/11	RS-12/13	RS-15
Catalog Number	14129	22825	20480	24278	18129	21089	23439
Epoch Time	97151.15454646	97155.72953055	97155.48066759	97155.63948386	97155.77709331	97155.83978477	97156.09969241
Element Set	488	581	976	102	390	993	223
Inclination	25.9242	98.5458	99.0438	98.5395	82.9275	82.9195	64.814
RA of Node	144.9168	230.2284	119.4572	198.5791	247.9023	287.7946	172.384
Eccentricity	0.6068807	0.0007717	0.0541414	0.0350657	0.0010286	0.0029031	0.0149653
Arg of Perigee	121.7683	282.4161	46.1503	218.6968	257.5696	335.0653	134.9118
Mean Anomaly	311.4183	77.6154	318.3043	138.8571	102.4308	24.9116	226.4065
Mean Motion	2.05879972	14.27727506	12.8323891	13.52630442	13.72378556	13.74082058	11.27527493
Decay Rate	0.00000108	0.00000004	0.00000014	-0.00000039	0.00000015	0.00000047	-0.00000039
Epoch Rev	10500	19229	34307	3942	49853	31746	10057
Satellite	RS-16	UO-11	UO-14	AO-16	DO-17	WO-18	EO-19
Catalog Number	24744	14781	20437	20439	20440	20441	20442
Epoch Time	97156.72863	97155.50514	97155.7834	97155.72858	97155.78571	97155.7833	97156.31126
Element Set	46	985	284	77	90	77	72
Inclination	97.2769	97.834	98.5186	98.5345	98.5403	98.5385	98.5428
RA of Node	62.0048	137.2455	237.7203	240.5651	241.4758	241.3716	242.5535
Eccentricity	0.0008688	0.0013115	0.0010174	0.0010589	0.0010515	0.0011005	0.0011453
Arg of Perigee	119.9759	44.5443	244.8647	246.7355	245.244	244.5521	242.8882
Mean Anomaly	240.2347	315.6817	115.148	113.2712	114.7648	115.4523	117.1131
Mean Motion	15.31385292	14.69556775	14.29961485	14.30009545	14.30152076	14.30119481	14.30234299
Decay Rate	0.00002477	0.00000149	-0.00000004	0.00000018	-0.00000002	-0.00000001	0.00000012
Epoch Rev	1433	70939	38444	38445	38449	38449	38459
Satellite	UO-22	KO-23	KO-25	IO-26	FORAT	MIR	Phase 3D 502 (est)
Catalog Number	21575	22077	22828	22826	22829	16609	99934
Epoch Time	97155.71308	97155.53783	97155.73622	97155.76901	97155.75723	97156.0647	96.2602552
Element Set	794	666	538	559	574	347	3
Inclination	98.3024	66.0778	98.5417	98.5453	98.5427	51.6517	60.0203
RA of Node	216.698	171.7181	230.5579	230.5066	230.6682	146.7643	342.7876
Eccentricity	0.0007084	0.0010064	0.0009422	0.0008565	0.000958	0.0005646	0.6752895
Arg of Perigee	296.0847	214.9123	265.234	282.0088	267.6796	115.3873	180.1221
Mean Anomaly	63.9611	145.1235	94.7763	78.0133	92.3281	244.7702	179.5089
Mean Motion	14.37071652	12.86303063	14.28180388	14.27837086	14.28164921	15.59476382	1.51063968
Decay Rate	-0.00000003	-0.00000037	0.00000027	-0.00000021	0.00000048	0.00002432	0.0002
Epoch Rev	30869	22612	16043	19231	19235	64513	2



**1997 REGISTRATION FORM
AMSAT-NA ANNUAL MEETING,
SPACE SYMPOSIUM**

October 17, 18 & 19

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Compiled by T.L. Kennedy Secondary School (VE3 TLK)

Wisp Power Saver

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The Wisp Power Saver (WPS), is a software and hardware package for saving power during unattended satellite operation with the WISP package. It is available free to Radio Amateurs. For many Wisp users, unattended satellite stations always have their PC, transceiver, power supply, rotator controller, TNC, PA, etc. powered up, 24 hours per day, even if there is not a satellite above the horizon for hours. Over time, this costs users much electricity and is also absolutely not good for your equipment.

During the spring of 1995, I found a post on KO-23 from Jose EB5AGV, who described a circuit based on timers and a PC parallel printer port. The idea occurred to me to develop a power saving system that is more accurate and would also switch off your PC. After I uploaded a message on Kitsat on this subject, I got so many replies that I started directly on the design. Unfortunately, changing QTH locations in the middle of the project delayed me in continuing WPS. However, when Erwin Wuyts, ON7VN finished his Trackbox update brought me back into the project. In December 1996, I finished the hardware circuit and the software, and it was beta tested.

What is WPS?

WPS consists of a small software program and a hardware circuit using a

microcontroller which will switch off all your equipment during the time that there is no satellite above the horizon. A few minutes before satellite AOS, WPS will wake up your complete hardware system (PC, transceiver, power supply, rotator controller, TNC, PA, etc.). After LOS of the satellite, WPS will shut down (sleep) your system. After a user determined time, WPS will wake up your equipment before the next AOS.

While WPS hardware and software is copyright protected it may be passed freely to others for Amateur Radio use. WPS is not permitted to be used or sold commercially. A guarantee for a correct functioning will not be given. Also, users have no right of recourse, in the event of a malfunction of WPS and/or the connected equipment to WPS.

Principle of WSP Operations

As your PC boots, Windows is started and GSC is running. After the first satellite pass, WPS.EXE is called and it will check if there is a new pass within *Sleep after LOS* parameters as specified in WPS.INI. For example, assume the current time is 20:00 and *Sleep after LOS* is 120 minutes. If there is a pass within the next 120 minutes WPS will close and do nothing. If there is no pass within the next 120 minutes WPS will send a time string to your WPS hardware. Then it will close all your open windows and exit

Windows. Figure 1 shows an example of a WPS screen. **Be careful** that there are **no DOS windows** opened as it is not possible to automatically close DOS applications.

As another example, assume the current time is 20:00 UTC with *Sleep after LOS* is 120 minutes. Wake up before AOS is 10 minutes, next pass will be at 23:45 UTC. WPS time string will be: 23:45 - 20:00 - 10 min = 215 min. As soon as WPS hardware receives the time string, it will wait 45 seconds and will then power down your complete system. At 23:35 UTC (23:45 - 10 min) WPS will wake up your complete system, your PC will boot and start all over.

WPS Hardware

Figures 2, 3, and 4 portray the WPS hardware consisting of a microcontroller which handles the time string sent by WPS.EXE. It is connected to a serial port, through a DB9 **fully** wired cable. It has a bi-color led which shows the status (Sleep/Wakeup). The output is an open-collector type, so that you can connect a relay or solid state relay to switch the mains of your equipment. WPS has a pushbutton to wake up your equipment if it is sleeping.

Where Can I Get WPS ?

WPS is **not** available as a kit, however schematics and PCB layout are included in the distribution file. You can obtain a programmed microcontroller only by contacting me. The price of the programmed microcontroller is US \$10 plus shipping [Benelux: 2 Dollar (50 BFR), Europe 3 Dollar (100 BFR) or World: 5 Dollar (150 BFR)]. I only accept US dollars or Belgian Francs. (Editor's note: ON4BCB is donating WSP profits to Phase 3D.) Also, anyone who has problems getting other WPS parts are asked to send me a message and I will see what I can do. Please note that I am not making any financial gain on the sale of WSP. As a result, it is not possible for me to pay the postage and other costs out of my own pocket.

The following WSP files are available via downloading from

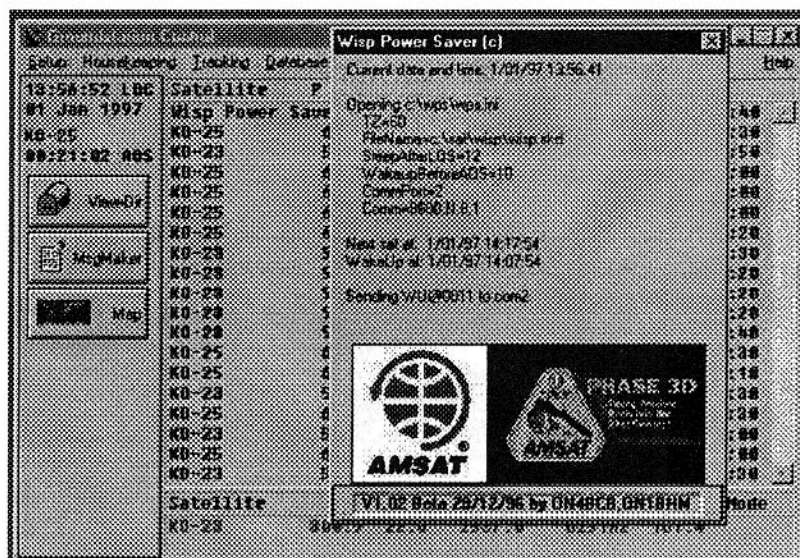


Figure 1. Example of Wisp Power Saver Screen.

- *wps/wpsdis.zip* - The **full** distribution version (including software, hardware in JPG,PCX,HPGL)
- *wps/wps.zip* - The latest software version (without hardware description) Version 1.02 Beta
- *wps/wpsjpg.zip* - The hardware description in JPG format (schematic, PCB layout & silk layout)
- *wps/wpspcx.zip* - The hardware description in PCX format (schematic,PCB layout & silk layout)
- *wps/wpsjpgl.zip* - The hardware description in HPGL format (schematic,PCB layout & silk layout)
- *wps/wps_scr.jpg* - A screen dump of the WPS software in JPG format
- *wps/wps.jpg* - A picture of the WPS hardware prototype in JPG format

Warning

It is ***not good*** to switch electronic devices ***On*** and ***Off*** several times a day. So ***do not*** set ***Sleep After LOS*** too fast. The idea of WPS was to switch off your system during the long periods without any satellite passes (5 to 10 hours). Normally WPS will shutdown once a day, which is no problem as we manually switch on our system one or two times a day.

Acknowledgements

A special thanks goes to the following:

- Guy Roelant, ON1BHM for writing my idea into an EXE file.
- Erwin Wuyts, ON7VN for future beta testing under Windows 95 32bit.
- Frank Saudemont, ON4CCF for beta testing the software and hardware under Windows 95.
- Julien Goethals, ON6GJ for beta testing the software and hardware under Windows 3.11.
- Willy Wittesaele, ON1AWU for the first tests with the microcontroller.
- Dirk Collone, ON1AEI for the first software version.

If WISP Power Saver becomes popular, users can ask Chris Jackson, G7UPN, C.Jackson@ee.surrey.ac.uk to implement the WPS.EXE directly into future versions of GSC, so you only will need to construct the hardware. ■

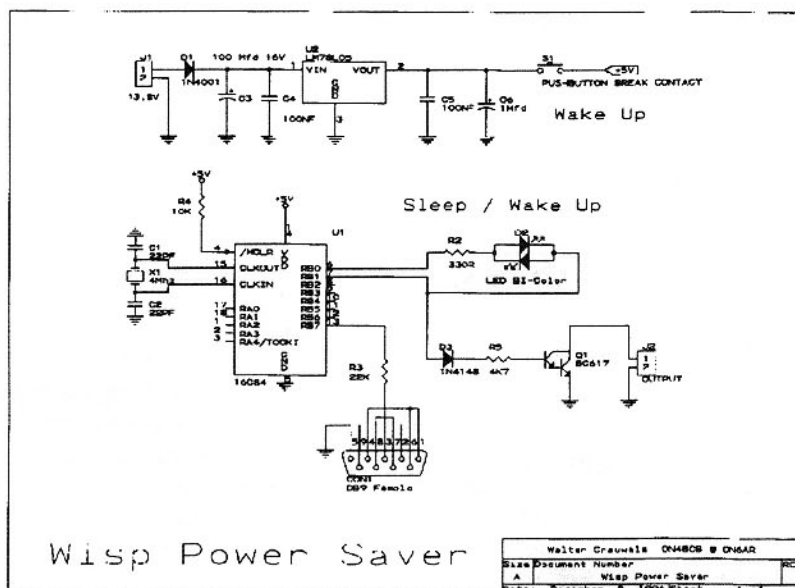


Figure 2. Wisp Power Saver schematic.

PCB layout for WPS hardware

The silk layout for WPS hardware

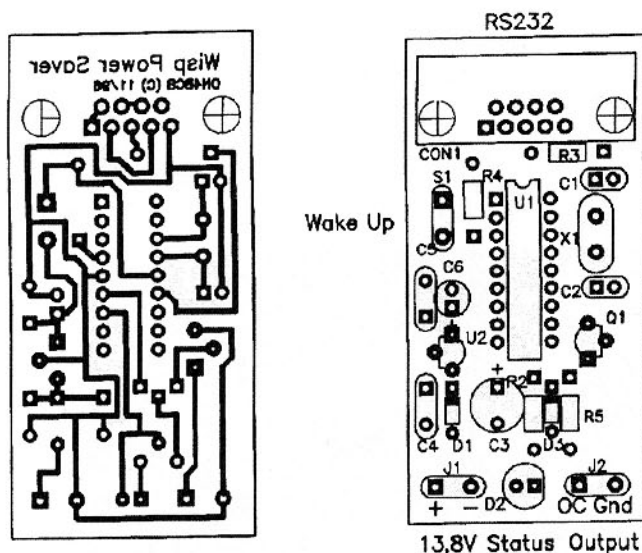


Figure 3. PCB layout for WISP Power Saver.

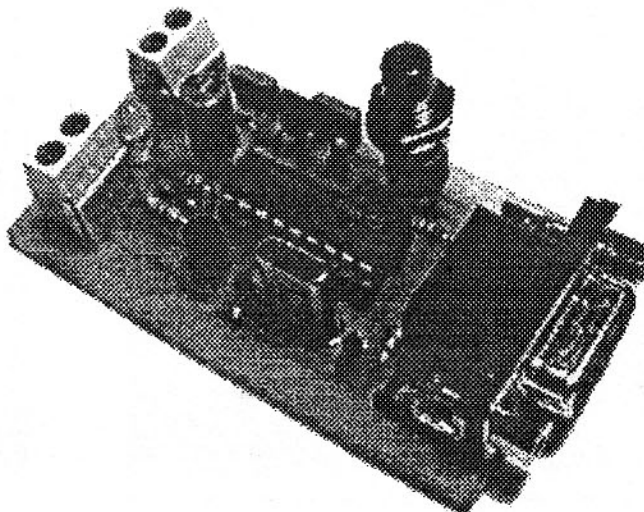


Figure 4. WISP Power Saver.

Field Ops Update: Dayton Hamvention Highlights

Barry Baines, WD4ASW

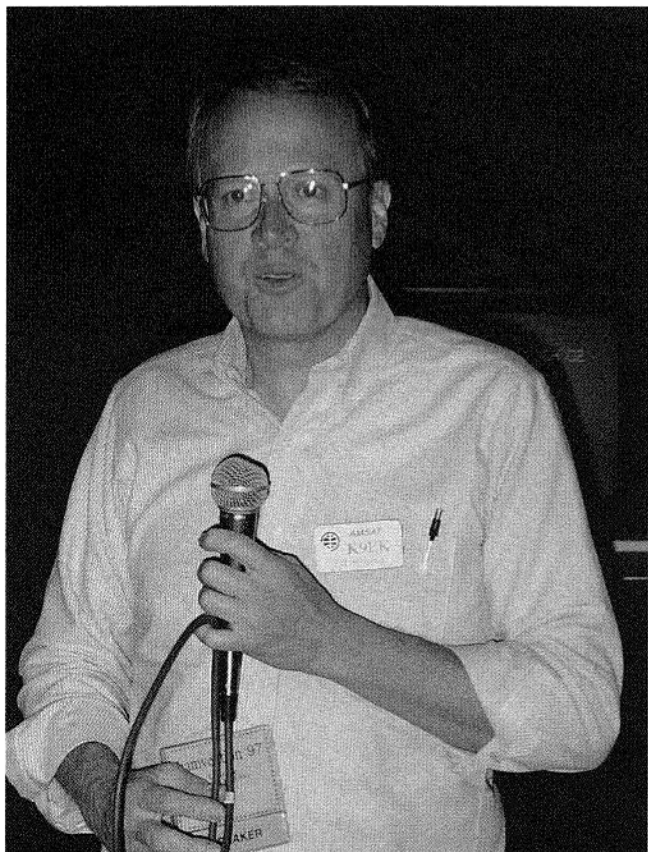
wd4asw@amsat.org

AMSAT enjoyed another success at the Dayton Hamvention. The annual event was marked by several notable achievements:

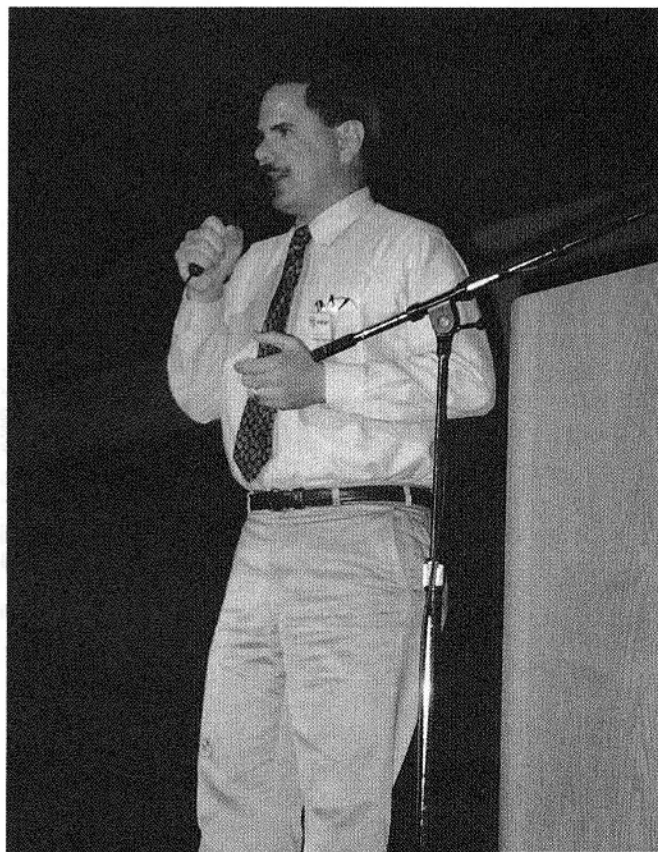
- Three AMSAT Forums were held at Hara Arena and were well attended vs. two Forums in 1996.
- AMSAT offered a new book (Paul Beckmann, WA0RSE's *P3G Interim Guide to P3D*) which was well received.
- Updated and expanded editions of Gould Smith, WA4SXM's *RS Operating Guide* and Keith Baker, KB1SF's *How to Use Amateur Radio Satellites* were available.
- As a new member promotion, AMSAT offered printed versions of Gary Rogers, WA4YMZ's *Working the Easy Sats* which was very well received. Copies were also offered for a \$5.00 donation.
- Terry Douds, WB8CKI, produced a new video on Phase 3D Integration efforts at Orlando, using footage shot by Keith Baker, KB1SF showing the transponders being installed on the spaceframe.
- Tim Stookey, N8AHD, built a 'Phase 3D Donation Fund Piggybank' based on a four foot scale model Ariane 5 model with Phase 3D mounted on the nose. Hamvention attendees were encouraged to put small change/bills into a slot on the rocket to help support AMSAT's Phase 3D costs.
- Eric Cottrell, WB1HBU, had a WISP demonstration running using recorded satellite passes stored on VHS video tape which provided the audio into a TNC which in turn was connected to his laptop.
- An enthusiastic group of AMSAT members stepped forward to help man the AMSAT booth.

The Hamvention weekend was May 16-18, the second year that Hamvention was held in mid-May. While Thursday, May 15 was cold and blustery as volunteers set up the AMSAT booth in the same site as previous years (445-448), weather during the hamfest weekend itself was very pleasant. As in previous years, there were a number of *old hands* who helped with preparations as well as manning of the booth during the Hamvention itself. Setup was quickly accomplished thanks to volunteer efforts by Keith Baker, KB1SF; Bill Tynan, W3XO; WB8CKI, N8AHD, Keith Pugh, W5IU; Ron Marosko, K5LLL and others as well as due to the great booth materials constructed several years ago by N4IFD that provide an outstanding booth arrangement which is easy to install and continues to serve AMSAT well.

A *help wanted* request was posted on AMSAT-BB on April 24 and a number of members stepped forward to volunteer some time to man the booth during the



Ed Krome, K9EK shared many tips for establishing a microwave Phase 3D station. (AMSAT-NA photo via Keith Baker, KB1SF)



Shuttle Mission Specialist and AMSAT member, Ron Parise, WA4SIR entertained Dayton Hamvention participants at the soldout Saturday evening. (AMSAT-NA photo via Keith Baker, KB1SF)

Hamvention itself. Thanks to the number of people who volunteered, we were able, prior to the opening of the Hamvention, to assign an individual to each of the six workstations for all day Friday and Saturday and most of Sunday. There were plenty of volunteers to assist the multitudes of attendees who wanted to establish or renew a membership, get an overview of *NOVA for Windows*, pick up the latest AMSAT publications, or obtain a new AMSAT t-shirt or ball cap. A total of 29 volunteers were assigned to various workstations at the booth during the course of the weekend.

Martha Saragovitz, AMSAT-NA Corporate Secretary and Bob Carpenter, W3OTC handled membership matters, Phase 3D donations, and WISP registrations. Bob had brought the AMSAT office computer to Dayton so that the members could inquire about their membership status. As in previous years, AMSAT enjoys a large number of membership renewals as attendees stop by the booth each year to pay their dues.

There were three AMSAT forums this year compared to two last year. The increase in forum time was due in part to the high attendance that AMSAT forums enjoy and the recognition by the Hamvention Committee that there is strong interest in the amateur satellite program. Keith Pugh, W5IU, served as moderator for the Beginner's Forum conducted by Barry Baines, WD4ASW. Despite the fact that the forum was scheduled to begin at 1205 on Friday, five minutes after the commercial area opened to the public, the room was filled to capacity by 1230. Barry provided an overview on satellite basics, reviewed where to find information on the satellite program (which included giving out a copy of WA4YMZ's *Amateur Satellite Resource Guide*), and highlighted the AMSAT field organization's ability to help newcomers with questions and suggestions on how to get on the satellites.

Phase 3D and SAREX were highlighted during the AMSAT forum given on Saturday afternoon. Due to the heavy workload at the Phase 3D Integration Lab, AMSAT engineering personnel responsible for P3D were not at Hamvention; AMSAT President Bill Tynan, W3XO, and Executive Vice President Keith Baker, KB1SF, provided updated information on the status of the satellite. Frank Bauer, KA3HDO, VP for Manned Space Programs, Ron Parise,

WA4SIR, Will Marchant, KC6ROL, and ARRL's Rosalie White, WA1STO, provided the audience with an overview of how amateur radio will be utilized with the International Space Station.

Ed Krome, K9EK, was the featured speaker during AMSAT's third forum, held on Sunday morning. Ed provided a general overview of working the microwave bands (1269 MHz and above), including a discussion of transverters, amplifiers, antennas, and what is currently available from various equipment suppliers. While not specifically addressing Phase 3D, Ed's presentation certainly provided information needed to establishing a Phase 3D ground station.

Hamvention is not only known for the extensive flea market and commercial areas, but also for the opportunity to socialize with folks from around the world. The annual AMSAT dinner was held at the Amber Rose Restaurant in old North Dayton. Well-organized by Gerd Schrick, WB8IFM, and assisted by Ed Collins, N8NUY, about fifty AMSAT enthusiasts enjoyed a buffet spread that was well prepared and moderately priced. The group consensus was that AMSAT should have next year's gathering at the same location.

The Saturday evening Hamvention banquet was sold out. AMSAT's Ron Parise, WA4SIR, was the banquet speaker. Ron is a mission specialist with NASA and has logged over 615 hours in space on two shuttle missions. His description of operating in Shuttle Amateur Radio Experiment (SAREX) from space and his personal experiences kept the audience's attention.

Once again, AMSAT made a significant impact

on the Dayton Hamvention through the quality and variety of forum presentations, a very active and professional booth display, and the opportunity to socialize and exchange ideas. Many thanks to the dedicated, hard-working volunteers who helped make our efforts such a success by volunteering to construct and man our exhibits, answer the many questions that were asked about the amateur satellite program, soliciting memberships, seeking Phase 3D donations, and encouraging support for AMSAT through donations received for our AMSAT materials. As always, Dayton Hamvention was both physically demanding and a fun-filled weekend coupled with a great sense of teamwork and cooperation that resulted in another success for AMSAT. Thanks! ■

Dayton Volunteers

Many thanks to the following members who volunteered a portion of their time at Dayton to help make AMSAT one of the best looking and most informative exhibits at the Hamvention.

- Barry Baines, WD4ASW, Jacksonville, FL
- Keith Baker, KB1SF, Xenia, OH
- Bob Carpenter, W3OTC, Rockville, MD
- Ken Chaffee, WA1QXR, Warwick, RI
- Eric Cottrell, WB1HBU, Lynn, MA
- Terry Douds, WB8CKI, Lancaster, OH
- James French, KD4DLA, Lincoln Park, MI
- Steve Gocala, KB8VAO, Youngstown, OH
- Ben Hall, WY4D, Roanoke, VA
- James Kelly, KK3K, Philadelphia, PA
- Pat Kilroy, WD8LAQ, Bowie, MD
- Thomas Lubbers, K8TL, Springfield, OH
- Jerry Malin, N2HV, Matthews, NC
- Ed Manuel, N5EM, Houston, TX
- Will Marchant, KC6ROL, Marshall, VA
- Ron Marosko, K5LLL, Houston, TX
- Morris 'Mac' McMillian, W8XF, Charleston, WV
- Glenn Moody, N4OUL, Louisville, KY
- John O'Hara, KB8TJX, Wellsville, OH
- Keith Pugh, W5IU, Ft. Worth, TX
- Greg Robinson, KB4NVD, Bluff City, TN
- Roy Robinson, K4EDU, Augusta, GA
- Mike Rudzki, N8MR, Livonia, MI
- Keith Pugh, W5IU, Ft. Worth, TX
- Martha Saragovitz, Silver Spring, MD
- Andy Skattebo, KA0SNL, Petersburg, IL
- Jerry Smyth, N8ULU, Dearborn, MI
- Tim Stookey, N8AHK, Sandusky, OH
- Bill Tynan, W3XO, Kerrville, TX
- Mike Wechsler, N4OFA, Kingsport, TN

AMSAT Comments on Amendment of Amateur Service Rules for Spread Spectrum Communication Technologies

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of
Amendment of the Amateur Service
Rules to Provide For Greater Use of
Spread Spectrum Communication
Technologies
WT Docket No.97-12

To: The Commission

COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

Introduction

The Radio Amateur Satellite Corporation (AMSAT) is a not-for-profit District of Columbia corporation established in 1969. It is the principal membership organization of the amateur satellite community in North America. Our current membership is approximately 7,000. Together with more than 30 of our affiliated organizations throughout the

world, we have constructed, launched and operated over two dozen satellites to date in the Amateur-satellite Service, of which many are presently in operation. AMSAT is currently constructing a new satellite presently designated "Phase 3D". Scheduled for launch later this year by the European Space Agency, it is designed to provide wide area amateur communications transmitting on amateur satellite bands from 2 meters to 1.25 cm. Phase 3D will provide approximately 500 kHz of bandwidth on all of the bands on which it will transmit, except for 2 meters where the bandwidth will be limited to 200 kHz by frequency coordination within the amateur community.

It is envisioned that part of Phase 3D's bandwidth will be used for digital transmission up to speeds of about 56 kb/s. The remainder is expected to be used for multiple access by many stations at a time using narrower band modes such as SSB, CW and other relatively narrowband modes, but could also be used for wide bandwidth modes, including SS, that require a linear transponder.

Since its inception, AMSAT has wholeheartedly been in favor of the development of new technologies in and for the Amateur and Amateur-satellite Services.

Summary

1. AMSAT generally supports the intent of the Commission's proposal contained in this NPRM to liberalize the rules governing the use of Spread Spectrum (SS) in the Amateur Service. We believe that SS may be one of those techniques that offers a potential for improved amateur communication, both terrestrially and via amateur satellites. However, we believe that modifications to the Rules as proposed in the NPRM are necessary in order to minimize the potential for destructive interference to satellite operation. We believe our suggested change to the Rules will enable SS and satellite operation to develop together more rapidly and effectively.

Discussion

2. AMSAT believes that SS is a technique that may very well prove a significant vehicle for facilitating improved communication between licensed amateurs, both terrestrially and through amateur satellites. However, our calculations, (see AMSAT's Reply Comments in RM-8737, paragraphs 3, 4 and 5), show that a single terrestrial SS station transmitting in the 435 MHz amateur satellite band, even with a power of only one watt spread over 10 MHz could increase the "noise" level up to 20 dB at a distance of 20 km, resulting in interference to reception of relatively weak amateur satellite signals. The situation worsens as the number of SS stations increases, and with the higher power levels permitted under the proposed Rules. The interference would also be worse at lesser separation distances.

3. We are also concerned that higher power terrestrial SS signals may find their way into satellite-borne transponders and be inadvertently retransmitted, in whole or in part. These concerns are held despite the good faith efforts incorporated in the NPRM to minimize interference from SS,

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such as the requirement for automatic power control for SS stations running more than 1 watt. At the 100 watt level, there is a significant likelihood of SS signals being unintentionally received by amateur satellites.

4. For these reasons, we respectfully request that the Commission adopt the limitation proposed below in an attempt to prevent such interference situations from developing, and still permit the growth and development of SS for both satellite and terrestrial applications.

AMSAT's Proposal

5. AMSAT contends that there is a feasible way to make SS available for both amateur terrestrial use and amateur satellite communication without the potential of destructive interference caused to existing satellite modes. We believe that this can be done by a clear statement in the Rules, that no SS transmissions shall take place in those ITU designated Amateur-satellite Service allocations below 2410 MHz, unless they are to or from amateur satellites, or short tests to confirm the proper operation of equipment in preparation for such work.

6. We believe that the Part 18 emissions above 2410 MHz make it irrelevant whether SS interference is present or not. In the higher microwave satellite bands antenna directivity should prevent any significant interference.

7. We respectfully request that the Commission add language to Section 97.305:

97.305 Authorized emission types

SS (spread spectrum) emissions are authorized on the following frequency segments:

- 420 - 450 MHz*
- 902 - 928 MHz
- 1240 - 1300 MHz*
- All Amateur frequencies above 2300 MHz*

* In the segments 435 - 438 MHz, 1260 - 1270 MHz and 2400 - 2410 MHz, SS emissions shall be used only for transmissions to or from amateur space stations, except for short tests to confirm

proper operation of equipment in preparation for such work.

Conclusion and Recommendations

8. AMSAT recommends that the Commission incorporate the above provision in any new Rules arising out of this proceeding, in order to protect amateur satellite users from interference that could result from terrestrial (non-satellite) SS communication. Such a provision would still permit the use of SS in conjunction with amateur satellite communication.

9. AMSAT believes that the suggested course will foster experimentation by the amateur community and encourage the

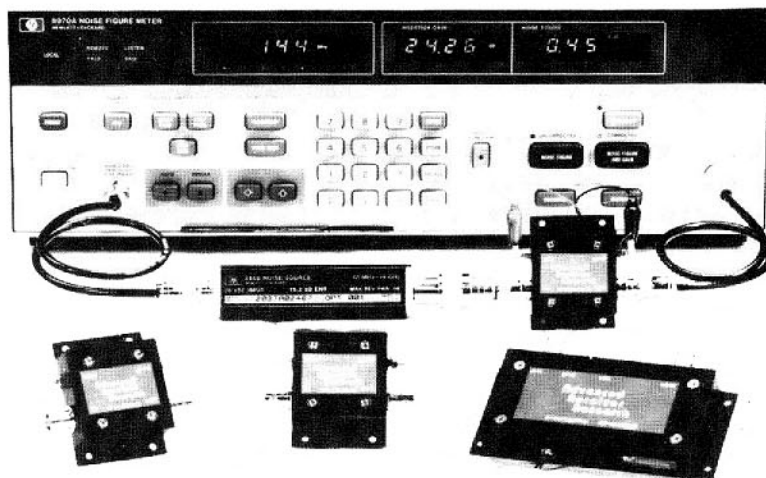
growth of SS, including its use in connection with amateur satellites. At the same time, it will preserve the capability of using current modes in conjunction with satellite operation, even by satellite users located in close proximity to other stations using SS for terrestrial applications.

Respectfully submitted,

Radio Amateur Satellite Corporation
P. O. Box 27
Washington, D.C. 20044

By Dr. Perry I. Klein, W3PK
Vice-President, Government Liaison
May 5, 1997 ■

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SP220VD	220-225	<1.9	15	0	DGFET	\$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	\$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	\$109.95
SP432VD	420-450	<1.9	15	-20	Bipolar	\$62.95
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SP432VDG	420-450	<0.55	16	+12	GaAsFET	\$109.95

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Background Information for Prospective Owners and Operators of Satellites Utilizing Frequencies Allocated to the Amateur-Satellite Service

by Arthur Feller, KB4ZJ; Ray Soifer, W2RS;
Robert Diersing, N5AHD; and Bill Tynan, W3XO

I. BACKGROUND

The Radio Amateur Satellite Corporation (AMSAT) is a non-profit scientific and educational corporation chartered in the District of Columbia (USA) in 1969.

A major activity of AMSAT is the construction and operation of space satellites either entirely by its own resources or in cooperation with other organizations with similar aims. Satellites designed, constructed, and operated by AMSAT and its collaborators are used by radio amateurs throughout the world and are highly valued resources for students and educators everywhere.

Organizations with similar purposes are now established in many countries and most use "AMSAT" somewhere in their name. Consequently, the Radio Amateur Satellite Corporation chartered in the USA is often referred to as "AMSAT-NA" where the "NA" indicates North America. Whenever the term AMSAT-NA is used in this document, it refers to the the USA chartered Radio Amateur Satellite Corporation.

Both the term "AMSAT" and its familiar globe and arrow symbol are trademarks of the Radio Amateur Satellite Corporation registered with the US Patent & Trademark Office.

II. PURPOSE OF THIS PAPER

AMSAT-NA offers this information to aid prospective owners and operators of satellites planned to operate in frequency bands allocated to the amateur-satellite service.

III. DEFINITIONS

Special terms for frequency management are defined in treaties which are honored by nearly every national government and operating agency in the world.

Although these terms are used in everyday language, whenever these special terms are used here, they are used with the meanings established in the treaties.

A list of many of these important frequency management terms and definitions is in Annex I. Citations used are explained in Annex II.

Here are two very important definitions which will be cited frequently throughout this paper.

"Amateur Service: A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest." [RR 53]

"Amateur-Satellite Service: A radiocommunication service using space stations on Earth satellites for the same purposes as those of the amateur service." [RR 54]

IV. TREATY REQUIREMENTS

Members of the ITU have obligated themselves to maximize the use of the radio frequency spectrum and to minimize interference. The treaties are the legal basis for administrations to regulate the amateur service and amateur-satellite service.

Extracts from treaty documents describing some basic principles of world frequency management, the amateur service, and the amateur-satellite service follow.

Members of the International Telecommunication Union [ITU] have agreed, among other things, that the Administrative Regulations, including the Radio Regulations "regulate the use of telecommunications and shall be binding on all Members ..." [CS 31]

"Administrations of the Members shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations ... or the other provisions of these Regulations, except on the express condition that harmful interference shall not be caused to services carried on by stations operating in accordance with the provisions of the Convention and of these Regulations." [RR 342]

"When transmissions between amateur stations of different countries are permitted, they shall be made in plain language and shall be limited to messages of a technical nature relating to tests ..." [RR 2732]

"Space stations in the amateur-satellite service operating in bands shared with other services shall be fitted with appropriate devices for controlling emissions in the event that harmful interference is reported ... Administrations authorizing such space stations shall inform the IFRB [now Radio Regulation Board] and shall ensure that sufficient earth command stations are established before launch to guarantee that any harmful interference which might be reported can be terminated by the authorizing administration ..." [RR 2741]

V. INTERNATIONAL FREQUENCY COORDINATION AND NOTIFICATION

Coordination and notification are the processes used to minimize the chances of causing interference to other amateur stations and amateur-satellite stations and to stations of other radiocommunication services.

A. International Coordination. Many different and, often, incompatible operations are conducted in amateur service and amateur-satellite service frequency allocations. To help minimize interference, band plans are drawn up by cooperating amateur groups.

World amateur band plans are recommended by the International Amateur Radio Union (IARU), the international

ANNEX I. DEFINITIONS

These definitions are from the Constitution (CS) of the International Telecommunication Union (ITU), Geneva, 1994; and the Radio Regulations (RR), Geneva, 1990, as amended by the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92), Geneva, 1992.

"Members of the Union shall have the rights and shall be subject to the obligations provided for in this Constitution and the Convention." [CS 24]

"Administration: Any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the International Telecommunication Union, in the Convention of the International Telecommunication Union and in the Administrative Regulations." [CS/An. 1002]

"Allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned." [RR 17]

"Allotment (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions." [RR 18]

"Assignment (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions." [RR 19]

"Radiocommunication Service: A service as defined in this Section [of the Radio Regulations] involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes." [RR 20]

"Amateur Service: A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest." [RR 53]

"Amateur-Satellite Service: A radiocommunication service using space stations on Earth satellites for the same purposes as those of the amateur service." [RR 54]

"Station: One or more transmitters and receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service, or the radio astronomy service. Each station shall be classified by the service in which it operates permanently or temporarily." [RR 58]

"Earth Station: A station located either on the Earth's surface or within the major portion of the Earth's atmosphere and intended for communication:

- with one or more space stations; or
- with one or more stations of the same kind by means of one or more reflecting satellites or other objects in space." [RR 60]

"Space Station: A station located on an object which is beyond, is intended to go beyond, or has been beyond, the major portion of the Earth's atmosphere." [RR 61]

"Telemetry: The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument." [RR 125]

"Space Telemetry: The use of telemetry for the transmission from a space station of results of measurements made in a spacecraft, including those relating to the functioning of the spacecraft." [RR 127]

"Telecommand: The use of telecommunication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance." [RR 128]

"Space Telecommand: The use of radiocommunication for the transmission of signals to a space station to initiate, modify or terminate functions of equipment on an associated space object, including the space station." [RR 129]

federation of national amateur radio organizations. Amateur satellite organizations, including AMSAT-NA, work in close cooperation with the IARU through the IARU Satellite Advisor and IARU AMSAT Frequency Coordinator.

Those contemplating the construction of a satellite to operate in the amateur-satellite service should contact the IARU AMSAT Frequency Coordinator early in the planning stage of the project. The Coordinator's function is to assist in the planning of operating, control, and telemetry frequencies for best results in conjunction with other amateur satellites as well as terrestrial operators around the world. Information about contacting the IARU Satellite Advisor and IARU AMSAT Frequency Coordinator is in Annex III.

B. International Notification.

Administrations are obligated by treaty to notify the ITU Radio Regulation Board of proposed amateur-satellite stations in advance of launch whenever coordination of the use of frequencies will be required with stations in other radio services.

[See RR Article 11, RR Article 13, RR 2741, and RR Appendix 4.]

Frequency allocations to the amateur-satellite service which are shared with other services are the bands 435 - 438 MHz, 1260 - 1270 MHz, 2400 - 2450 MHz, 3400 - 3410 MHz (available in Regions 2 and 3 only), 5650 - 5670 MHz, 10.45 - 10.55 GHz, 76 - 81 GHz, 144 - 149 GHz, and 241 - 248 GHz.

If amateurs in more than one country are involved in the project, a single country of license must be agreed upon and the appropriate arrangements for notification made through its administration.

Formal ITU notification is not required for the use of bands allocated to the amateur service and amateur-satellite service exclusively. Even so, international notification of the use of frequencies in exclusive bands is good advertising directed to administrations world-wide. (Administrations generally determine how votes are cast at World Radiocommunication Conferences.) The future of the amateur service and the amateur-satellite service depends upon these people seeing that there is value in maintaining their allocations.

USA licensees must inform the FCC well in advance of launch no matter which amateur-satellite frequency allocations will be used. [See 47 CFR 97.207(g), (h), and (i).] AMSAT-NA can assist USA licensees with these procedures.

VI. OPERATIONAL GUIDELINES

The following operational guidelines, based on interpretations by AMSAT-NA of the Radio Regulations and good amateur practice, are intended to help in planning the missions, management, and control of satellites planned to operate in the amateur-satellite service.

Organizations building satellites should compare their mission plans to the requirements of the amateur-satellite service. Then, they should determine if it is possible to comply with the requirements of the amateur-satellite service or if licensing and operation should be in some other radio service which is more consistent with the nature and requirements of the mission.

A. The purposes of an amateur satellite should be:

(1) To provide communication resources for the general amateur radio community and/or

(2) To conduct technical investigations in all respects consistent with the Radio Regulations. [See RR 53 and RR 54.]

Technical investigations carried out using frequencies allocated to the amateur-satellite service should be relevant to the development of "radio technique," that is, have a reasonable possibility of application to the development of radio communication systems. [See RR 53 and RR 54.]

Examples of such technical investigations include: propagation studies, operational analysis of protocols used for digital voice and data communication, development of attitude determination methods, development of command and control procedures, studies of radiation effects on various electronic components, studies of meteor trail reflection, and measurement of the orbital environment useful in designing future amateur satellites.

While many other types of technical investigations are conceivable, those not having a reasonable possibility of application to radio communication systems are probably not in accordance with the treaty requirements. An administration can reject whatever it

decides is inappropriate use of the amateur-satellite service or questions may be raised by other administrations.

B. Station Control. All stations operating in the amateur service and the amateur-satellite service, including space and Earth stations, must be controlled by "duly authorized persons," that is, licensed amateur radio operators who must be acting "solely with a personal aim and without pecuniary interest." [See RR 53 and RR 54.]

Even with these limitations, organizations and amateurs have common interests and work together for their mutual benefit. (For this discussion, an organization can be a university, research institute, for-profit or not-for-profit corporation, association, club, or other similar entity.)

AMSAT-NA, for example, is an organization which owns and builds space stations to operate in the amateur-satellite service. But, because it is an organization and not an individually licensed radio amateur, it may not control an amateur station. Licenses under which AMSAT-NA owned amateur stations are operated are issued either in the name of an individually licensed amateur radio operator or an amateur radio club (in this case,



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AMSAT-NA itself) where a licensed amateur radio operator is named on the license as trustee (the person responsible) for the club station.

In every case, an individual licensed amateur radio operator, who is neither employed nor paid by AMSAT-NA, is legally responsible for the operation of every amateur station or amateur-satellite station.

Commonly, the licensee is an unpaid member of the organization which owns the amateur station equipment or is a volunteer acting in close association with it. In these cases, the owner's interest and the licensee's "personal interest" are usually the same.

Of course, it is theoretically possible (although to the best of our knowledge, it has never occurred in practice) that the licensee or trustee of an amateur station or amateur-satellite station may determine that something he or she has been requested to do is not in accordance with the rules and regulations of his/her administration. If this happens, the licensee would inform the organization and, if possible, they would work out a solution that satisfies and protects both.

Thus, the individual responsibility of the licensed amateur radio operator, effectively imposed by the Radio Regulations, works as a kind of legal safety check for the organization and the amateur to protect both of their interests as well as that of the amateur-satellite service itself.

This arrangement has worked successfully and effectively for AMSAT-NA and its predecessor organizations since the first amateur satellite (OSCAR-1) in 1961.

C. Multi-service Satellites. A "multi-service satellite" is a space station which operates in frequency bands allocated to the amateur-satellite service and one or more additional satellite services. Even though the space station is part of a shared platform, all operation on frequencies allocated to the amateur-satellite service must meet the requirements of the amateur-satellite service.

Transmissions in frequency bands allocated to the amateur-satellite service

should not be used, for example, for routine telecommand, telemetry, or other operation involving the portion which is in another service. [See RR 53 and RR 54.]

D. Plain Language. The amateur-satellite service, by its nature, involves stations of more than one country. International communication between amateur stations in different countries must be in plain language. [See RR 2732.] The plain language requirement includes telemetry and data exchanged between users.

To meet the plain language requirement, technical descriptions of all emissions, codes, and formats must be made publicly available. No system intended to conceal the meaning of a transmission may be used.

Publication can be in a variety of ways. Use the amateur radio press: *The AMSAT Journal* published by AMSAT-NA, *OSCAR News* from AMSAT-UK, or *AMSAT-DL Journal*; or, general circulation periodicals such as *QST*, *CQ*, *73*, or *Radio Communication*. Use electronic publications: AMSAT-BB reaches around the world quickly and cheaply. AMSAT-NA world wide web and FTP sites are accessible world-wide.

Whenever possible, publish prior to launch or as soon as possible thereafter.

For more information about electronic publishing, see Annex IV.

NOTE: Space telecommand transmissions for critical spacecraft functions are generally accepted as exempt from the requirement to use plain language.

E. Open Access. All telecommunication facilities, except telecommand, operating in amateur-satellite service allocations should be open for use by amateur radio operators world-wide. All experiments utilizing frequencies allocated to the amateur-satellite service should be freely available for use by radio amateurs world-wide and for reception by students and educators.

F. Broadcasting. The broadcasting service is "a radiocommunication service in which the transmissions are intended for direct reception by the general public." [See

CS/An. 1010.] Broadcasting is not a function of the amateur service or of the amateur-satellite service and is, therefore, not permitted. However, the transmission of bulletins and data intended for reception by licensed amateurs is not considered broadcasting nor are other types of messages intended primarily for licensed amateurs which may also be received by non-amateurs.

VII. PUBLIC RELATIONS

Public announcements, press releases, and other public relations items concerning satellites to be operated in the amateur-satellite service are valuable tools for maintaining frequency allocations for the amateur service and amateur-satellite service and stimulating interest in amateur radio.

Frequency allocations are highly contested. Those voting at World Radiocommunication Conferences must be kept aware of how the amateur-satellite service benefits the people of their countries. Direct contact with administration officials is very important, should be sought, well planned, and well maintained.

Good public relations helps amateur radio grow better. More exposure of the amateur service and amateur-satellite service will attract more people to amateur radio. Everyone benefits from the influx of new members into the amateur radio community.

VIII. CONCLUSION

Good planning of an amateur-satellite project requires care and appropriate clear objectives to assure the success of the project. AMSAT-NA provides this information in order to help prospective amateur-satellite builders achieve their goals.

For more information, contact AMSAT-NA. See the details in Annex V.

ANNEX II. CITATIONS AND FINDING IMPORTANT DOCUMENTS

Citations Explained

CFR Code of Federal Regulations,
National Archives and Records

Administration (USA). Specific rules and regulations are cited using the title number, then "CFR", then the specific rule provision.

"Title 47-TELECOMMUNICATION" contains all rules and regulations of Federal Government agencies and departments (including FCC) on the subject of telecommunication.

CS Constitution of the International Telecommunication Union (ITU), Geneva, 1992. Specific provisions are cited as "CS" followed by the provision number from the left hand margin of the document. The latest version of both the Constitution and Convention of the International Telecommunication Union, including Optional Protocol, Resolutions, and Recommendations, are in the Final Acts of the Additional Plenipotentiary Conference, Geneva, 1992.

RR Radio Regulations, Geneva, 1990, as amended by the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92), Geneva, 1994. Specific provisions are cited

as "RR" followed by the provision number from the left hand margin of the document

Finding These Documents

CFR and other USA Government publications are available in most libraries in the USA and at major libraries in many countries (ask the reference librarian). Also, copies are available in United States Information Agency (USIA) libraries at embassies and consulates around the world. Copies of individual volumes in the CFR series can be purchased from the Superintendent of Documents, US Government Printing Office, Mail Stop SSOP, Washington, DC 20402-9328 USA, telephone: +1 (202) 783-3238.

ITU Convention and Constitution, Radio Regulations, and other ITU documents are distributed to administrations of Members and recognized operating agencies. Copies can be purchased from the International Telecommunication Union, ITU Sales Service, Place des Nations, 1211 Geneva 20, Switzerland; TELEFAX: +41 22 730 51 94. For additional information including a

complete catalog of documents, check the ITU GOPHER server [ties.itu.ch] or web server [<http://www.itu.ch>] providing ITU Telecom Information Exchange Services (TIES).

ANNEX III. IARU CONTACTS

IARU AMSAT Frequency Coordinator:
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5034 Adelaide SA
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Telefax: +61 8 204 7100

IARU Satellite Advisor:
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3650 Hillcrest
Republic of South Africa
E-mail: zs5akv@amsat.org
Telefax: +27 31 765 6456

The International Amateur Radio Union
International Secretariat
P.O. Box 310905
Newington, CT 06131-0905 USA
E-mail: iaru@iaru.org
Telephone: +1 (860) 594-0200
Telefax: +1 (860) 594-0259

ANNEX IV. ELECTRONIC PUBLICATION

AMSAT publishes information through its world wide web server [<http://www.amsat.org>] and its FTP site [<ftp://ftp.amsat.org>].

More information is available from Paul Williamson, KB5MU, AMSAT Vice-president for Electronic Publications, electronic mail address: kb5mu@amsat.org.

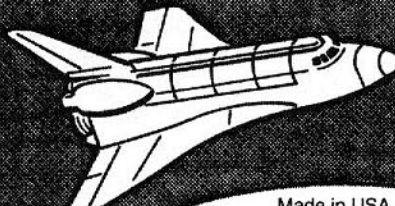
ANNEX V. CONTACTING AMSAT

For more information, contact:

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Silver Spring, MD 20910
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AMSAT Journal Telemetry

Dr. A. C. GEE, G2UK, SK

It is with great sadness that we report the death of the former Chairman of AMSAT-UK. Dr. A C Gee died in hospital at Lowestoft, Suffolk, England during the early hours of 19th May 1997, aged 84 years. He was re-admitted to hospital after complications following a hip operation early in the month. He leaves wife Marjory, son Richard, and daughter Marion. AMSAT extend sincere condolences to the family.

The funeral took place on 29th May 1997 at St. Michael's Church, Oulton, Oulton Broad, Suffolk. It has been suggested by the family that remembrance donations be sent to AMSAT-UK funds.

"Doc" Gee, as he was referred to by many friends, was an AMSAT-UK member from the formation of the Organization (membership number 0025). He became the Chairman in 1979, and resigned from office in 1992 because of ill health. He was a friend of this writer for over thirty years, and certainly a *wise head* to discuss a problem on most subjects. He was, up to three weeks prior to his death, operating through the RS satellites, and will be remembered as the writer of the Satellite column in *Radio Communications* for several years.

Arthur was also most interested in the new Phase 3D satellite, and any information about that satellite I could give during my visits to his home, or via telephone, was received with great interest. His interests were also far ranging even outside Amateur Radio.

G2UK was a skilled model-maker of sailing ships, Founder member and Commodore of the Lowestoft Cruising Club. Member of Royal Norfolk and Suffolk Yacht Club. Member of Waveney and Oulton Broad Yacht Club. He was an amateur astronomer and member of Norwich Astronomical Society and editor of its newsletter. He was also an enthusiastic steamboat owner, one time radio operator/medic to an expedition based to Orland Island off the coast of Sweden. The base was set up to record the eclipse of the Sun. Information was then transmitted to Greenwich to correct the TIME machine

(GMT). His amateur radio call signs date back to 1935.

He was a member of the Royal Naval Wireless Auxiliary Reserve, which led to a lifelong interest in Amateur Radio (1935-1997).

Member of the London Wireless Club, now RSGB. Member of BARTG, RAYNET and ISWL. Co-Director of Data Publications and the now defunct Radio Constructor magazine. Medical Officer of Health to the old Suffolk Counties Hospital Area. He was well liked and a respected citizen of Oulton Broad, where he had lived for over fifty years. Arthur will be missed by many members of the amateur radio fraternity world wide.

Rest in Peace Arthur. A good friend and adviser to a vast number of people. - Ron Broadbent. G3AAJ. AMSAT-UK, 20th May 1997. ■

North Texas Balloon #7B Goes to Italy!!!

The seventh mission of the North Texas Balloon Project (NTBP) finally took to the air at 10:14 a.m. on 19 April 1997 from the Cleburne, TX Municipal Airport. Two hours later, it had a soft landing in a pasture near Italy, TX and was recovered by NTBP personnel within 30 minutes. The launch was delayed from its scheduled time of 9:00 CDT. by local-winds-aloft data not being available and an unexpected burst of the first balloon during inflation, the cause of which was unknown. But the parachute spreader ring, swivels and woven tow line allowed a nice easy descent.

The GPS experiment experienced two separate difficulties during the flight. The Delorme Tripmate GPS receiver failed to maintain track on enough GPS satellites to provide accurate altitude data. In fact, the entire altitude data set was suspect and finally disregarded. However, the

Tripmate did provide accurate Latitude and Longitude data. The other difficulty was related to the GPS beacon transmitter itself. The Yaesu FT-530 output power level dropped to near zero at 75 minutes into the flight. It has not been determined why the HT power dropped, but extremely cold temperatures are a likelihood.

The FM crossband voice repeater was the highlight of the mission. The following locations were able to hear and/or work through the balloon. In Texas, Ft. Worth, Dallas, Houston, Plano, Irving, San Angelo, San Antonio, Kerrville, Newberry; Clovis, NM; in Louisiana, Shreveport and Bossier City; Wichita and Hays in Kansas; and last but not least Vicksburg, Mississippi! A great time was had by all operating through the balloon repeater.

In addition, the 35mm still camera took some great pictures every 3.3 minutes which lasted nearly the entire ascent leg. These photos will be scanned and will be available for downloading within the next few weeks at our WWW site: <http://procorp.com/procorp/ntbp/index.htm>. Those wanting QSL/SWL cards for NTBP #7B, please send e-mail requests to kg5ie@flash.net.

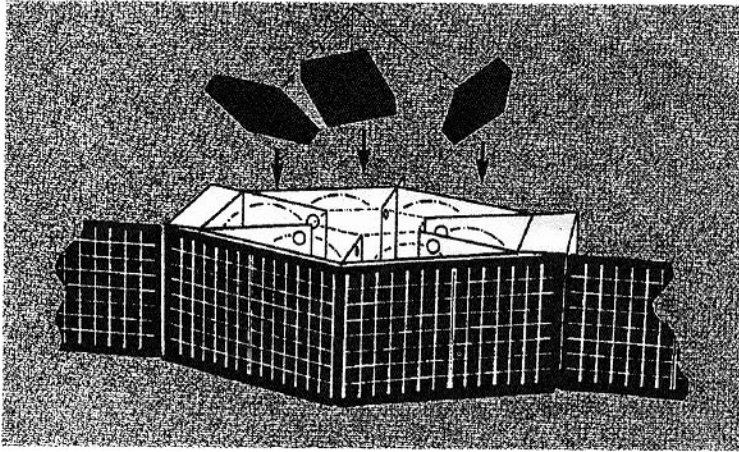
I would like to sincerely thank the Lockheed-Martin ARC in Fort Worth for supporting the NTBP. It took two very, very troublesome years to accomplish our seventh flight. I am extremely proud of the extraordinary patience and efforts that the members of the LMARC displayed throughout this difficult time. Hopefully, we'll be ready to fly again soon! *Via Doug Howard, KG5OA.* ■

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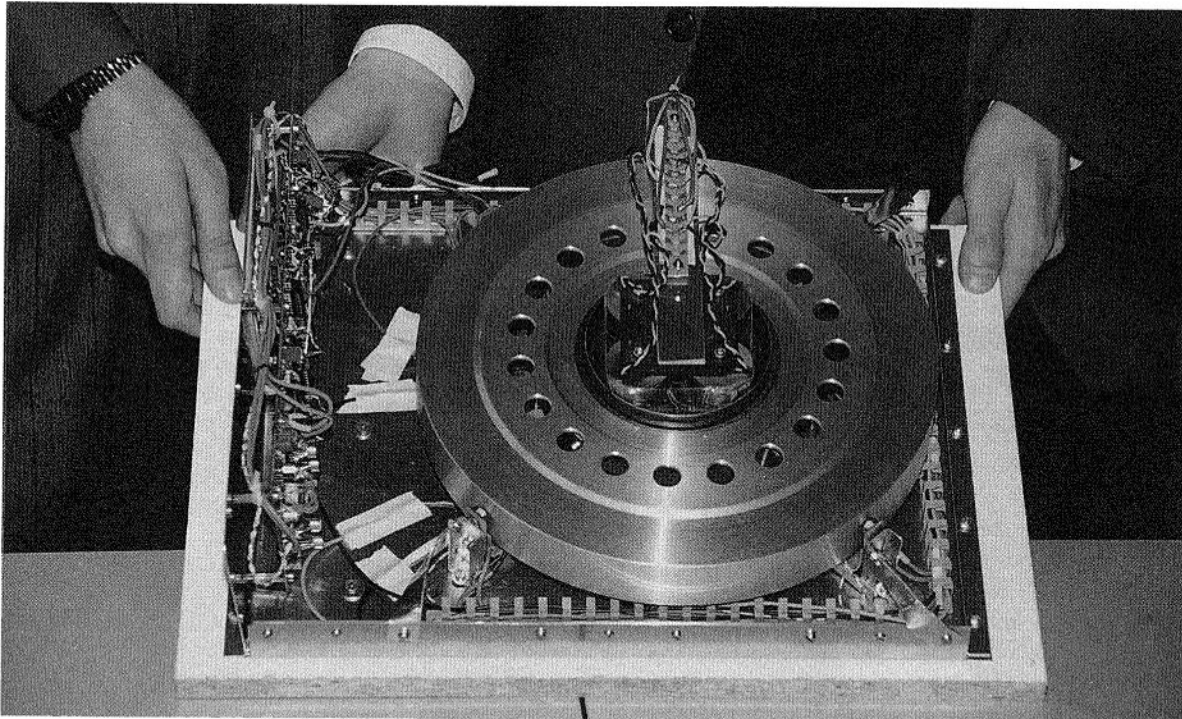
Phase 3D Momentum Wheels



Today, most satellites use momentum wheels for attitude control. This way, the antennas and the solar generator can always be pointed in the right direction. Conventional momentum wheels with ball bearings frequently cause problems since in the vacuum of space the lubrication of the bearings is very difficult. For more than twenty years, it has been proposed to use magnetic bearings working with no physical contact and thus no wear. The development of such systems turned out to be rather difficult. For space applications, bearings with two active controlled axes had not been developed to the point which allowed them to be tested in space. (AMSAT-DL diagram)



From left to right: Prof. Dr. Cramer, TH Darmstadt; Ralph Zimmerman, DL1FDT; Michael Scharfe, DK7UX; AMSAT-DL Structural Specialist Konrad Müller, DG7FDQ; and Phase 3D Project Manager Karl Meinzer, DJ4ZC. Michael Scharfe and Ralph Zimmerman developed Dr. Meinzer's basic wheel concept with support from Darmstadt Technical University and Konrad Müller. (AMSAT-DL photo)



A momentum wheel system has been developed for AMSAT Phase 3D by Dr. Karl Meinzer, DJ4ZC in the Zentrales Entwicklungslabor für Elektronik. It is hoped that this generally makes available a technology which will improve the reliability of future 3-axis controlled spacecraft. Furthermore, it is hoped that the experience gained with magnetic levitation systems will find applications in other areas such as magnetic levitation trains and in large electromechanical projection display systems. (AMSAT-DL photo)

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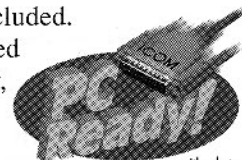
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